Installation Restoration Program (IRP) Final Remedial Investigation/ Feasibility Study Work Plan

143rd Combat Communications Squadron
Seattle Air National Guard Station
Washington Air National Guard
Seattle, Washington

July 1996

Air National Guard Readiness Center
Andrews AFB, Maryland

Tech 111-001

KCSlip4 39008

SEA405538

DEPARTMENT OF THE AIR FORCE
241st CIVIL ENGINEERING SQUADRON (AMC)

FILE

31 JUL 1996

MEMORANDUM FOR 143 CBCS/CC

FROM: 241 CES/CEV
104 Air Defense Lane
Tacoma WA 98430-5022

SUBJECT: Final Remedial Investigation/Feasibility Study Work Plan for Seattle ANGS, Seattle, Washington

Attached is the Final Remedial Investigation/Feasibility Study (RI/FS) Work Plan for Seattle Air National Guard Station (ANGS), Washington. It is provided for your information. Copies have also been provided to Washington Department of Ecology and to the U.S. Environmental Protection Agency. If you have any questions or comments please contact me.

S. P. PURVINE, GS-11, WA ANG
Environmental Coordinator

Attachment: RI/FS Work Plan

cc: 252 CCG/DC w/o atch

KCSlip4 39009

SEA405539

DEPARTMENT OF THE AIR FORCE
241st CIVIL ENGINEERING SQUADRON (AMC)

FILE

3 1 JUL 1996

MEMORANDUM FOR Washington State Department of Ecology
Northwest Regional Office
Attn: Mary O'Herron
3190 - 160th Avenue S.E.
Bellevue WA 98008-5452

FROM: 241 CES/CEV
104 Air Defense Lane
Tacoma WA 98430-5022

SUBJECT: Final Remedial Investigation/Feasibility Study Work Plan for Seattle ANGS, Seattle, Washington

1. Attached are two copies the Final Remedial Investigation/Feasibility Study (RI/FS) Work Plan for Seattle Air National Guard Station (ANGS), Washington. They are provided for your information. A copy has also been provided to Mark Ader, at the U.S. Environmental Protection Agency, Region X.

2. If you have any questions please contact me. I am available at the above address or telephone (206) 512-8569.

S. P. PURVINE, GS-11, WA ANG
Environmental Coordinator

Attachment: RI/FS Work Plan (2 copies)

cc: 252 CCG/DC w/o atch

KCSlip4 39010

SEA405540

DEPARTMENT OF THE AIR FORCE
241st CIVIL ENGINEERING SQUADRON (AMC)

FILE

31 JUL 1996

MEMORANDUM FOR Mark Ader, ECL-115
U.S. Environmental Protection Agency, Region X
1200 - Sixth Avenue
Seattle, WA 98101

FROM: 241 CES/CEV
104 Air Defense Lane
Tacoma WA 98430-5022

SUBJECT: Final Remedial Investigation/Feasibility Study Work Plan for Seattle ANGS, Seattle, Washington

1. Attached is the Final Remedial Investigation/Feasibility Study (RI/FS) Work Plan for Seattle Air National Guard Station (ANGS), Washington. It is provided for your information. Copies have also been provided to Mary O'Herron at the Northwest Regional Office of the Washington State Department of Ecology.

2. If you have any questions please contact me. I am available at the above address or telephone (206) 512-8569.

S. P. PURVINE, GS-11, WA ANG
Environmental Coordinator

Attachment: RI/FS Work Plan

cc: 252 CCG/DC w/o atch

KCSlip4 39011

SEA405541

ERM-West, Inc.

5111 N. Scottsdale Road
Suite 108
Scottsdale, AZ 85250
(602) 990-9350
(602) 990-0107 (Fax)

July 26, 1996

DUPLICATE

ERM

Mr. Michael Grimm
Air National Guard
ANG/CEVR
3500 Fetchet Avenue
Andrews Air Force Base, Maryland 20762

SUBJECT: Contract DAHA90-94-D-0014/16
Final Remedial Investigation/Feasibility
Study Work Plan for Seattle ANGS, Seattle,
Washington

Dear Mr. Grimm:

ERM-West, Inc., has completed the Final document for Task 2C of the above referenced delivery order. We are pleased to provide the Air National Guard with three copies of the Final Remedial Investigation/Feasibility Study Work Plan for Seattle ANGS, Seattle, Washington. We are providing copies of the work plan to Mr. Steve Purvine to forward to the Washington Department of Ecology and to EPA Region X. ERM will send the electronic files in IBM format under separate cover next week.

Please feel free to contact me at (602) 990-9350 if you have any questions or comments regarding the enclosed work plan.

Sincerely,

ERM-WEST, INC.

Robin G. Weesner

Robin G. Weesner, R.G.
Project Manager

RGW/tro/6016.23

Enclosures

cc: Mr. Steve Purvine, ANG 241 CEC (five copies)
Ms. Jeanie Kampschroeder, NGB-AQC-E (cover letter only)
Mr. Jim Quinn, ERM-West, Inc., Walnut Creek (one copy)

Installation Restoration Program (IRP)
Final Remedial Investigation/
Feasibility Study Work Plan

143rd Combat Communications Squadron
Seattle Air National Guard Station
Washington Air National Guard
Seattle, Washington

July 1996

Prepared For:

Air National Guard Readiness Center
Andrews AFB, Maryland

Prepared By:

ERM

ERM-West, Inc.
5111 N. Scottsdale Road, Suite 108
Scottsdale, Arizona 85250

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LIST OF ACRONYMS

Acronym	Definition
ANG	Air National Guard
ANG/CEVR	Air National Guard Readiness Center/Installation Restoration Program Branch
ANGS	Air National Guard Station
AOC	Area of Concern
ARARs	applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
AWQC	Ambient Water Quality Criteria
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CCSQ	Combat Communications Squadron
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DERP	Defense Environmental Restoration Program
DQOs	data quality objectives
EDR	Environmental Data Resources, Inc.
EPA	United States Environmental Protection Agency
ERM	ERM-West, Inc.
FS	Feasibility Study
FFS	focused feasibility study
GPR	Ground penetrating radar
IRP	Installation Restoration Program
LTM	long-term monitoring
MCLGs	Maximum contaminant level goals
MCLs	maximum contaminant levels
mg/kg	milligrams per kilogram
MTCA	Model Toxics Control Act
NPDES	National Pollutant Discharge Elimination System
OpTech	Operational Technologies Corporation
PA	Preliminary Assessment
PID	photoionization detector
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
PP Metals	Priority Pollutant trace metals
RA	remedial action
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RI/FS	Remedial Investigation/Feasibility Study

LIST OF ACRONYMS

Acronym	Definition
SARA	Superfund Amendments and Reauthorization Act
SI	Site Investigation
SSHP	Sitewide Safety and Health Plan
SVOCs	semivolatile organic compounds
TPH	total petroleum hydrocarbons
TVH	total volatile hydrocarbons
VOCs	volatile organic compounds
WDOE	Washington Department of Ecology

SECTION 1.0

INTRODUCTION

ERM-West, Inc., (ERM) has prepared this Remedial Investigation/ Feasibility Study (RI/FS) Work Plan in support of the planned RI/FS at the 143rd Combat Communications Squadron (CCSQ), Seattle Air National Guard Station (Seattle ANGS) in Seattle, Washington (Figure 1-1). The study is part of the Installation Restoration Program (IRP) of the Air National Guard (ANG). This work is being performed under contract DAHA90-94-0014 between ERM and the National Guard Bureau, Departments of the Army and the Air Force. The Air National Guard Readiness Center/Installation Restoration Program Branch (ANG/CEVR) is providing technical and project management oversight of this investigation on behalf of the ANG.

This RI/FS Work Plan follows the recommended ANG/CEVR format and contains the basic contents suggested in the United States Environmental Protection Agency (EPA) document *Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA* (EPA, 1988).

The objectives of Seattle ANGS RI/FS are to initiate and complete the RI/FS for groundwater and soils at the Burial Site Area of Concern (AOC), heretofore referred to as "IRP Site 1 - Burial Site".

This introduction includes the following subsections:

- Project Objectives and Scope;
- Overview of the IRP;
- General Investigation Approach; and
- Work Plan Structure.

1.1 Project Objectives and Scope

The following sections summarize the objectives and scope of work for the RI/FS activities at Seattle ANGS.

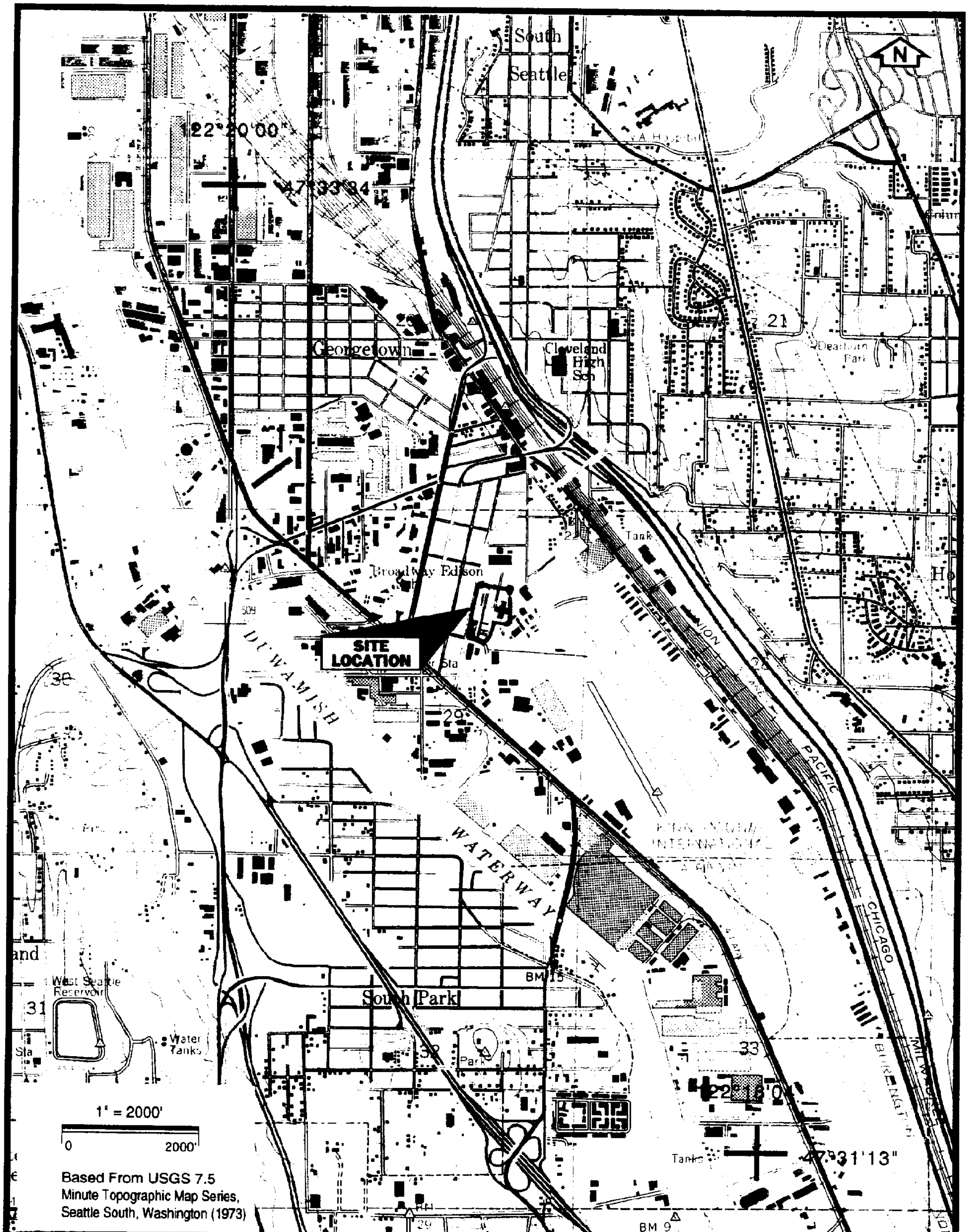

FIGURE 1-1 G:\CAD\DWGS\6016\ANG-FMAT	LOCATION MAP OF SEATTLE AIR NATIONAL GUARD STATION, SEATTLE, WASHINGTON 143rd CCSQ, SEATTLE ANGS Seattle, Washington	ERM

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1.1.1 Objectives and Scope of the Remedial Investigation

The specific objectives of the RI are stated below.

- Provide additional data to assist in defining the vertical and horizontal extent and magnitude of soil and groundwater contamination at the investigated site.
- Determine site-specific background concentrations in soil and groundwater.
- Refine the understanding of the pathways of contaminant migration.
- Define site physical features, facilities, and hydrogeologic conditions that could affect contaminant migration, containment, or cleanup.
- Determine the nature and extent of threat to human health and the environment.

The overall objective of the Seattle ANGS RI is to provide an accurate, precise, and representative summary of the current vertical and horizontal extent of contamination within the soil and groundwater associated with IRP Site 1 - Burial Site. Information obtained during the investigation will be used during the FS phase as the scientific basis for identifying and selecting the most appropriate remedial alternatives for the site.

1.1.2 Objectives and Scope of the Feasibility Study

The specific objectives of the FS are stated below:

- Determine the types of response actions to be considered (decision document, FS, remedial design, or remedial action).
- Develop, screen, and evaluate potential remedial alternatives.
- Recommend the most cost-effective remedial alternatives that adequately protect human health, welfare, and the environment.

The FS will be conducted in accordance with Federal and State guidelines. The FS will develop, screen, and analyze alternatives for remediation of impacted soil and groundwater as necessary at the IRP site.

1.2 Installation Restoration Program (IRP)

The Defense Environmental Restoration Program (DERP) was established in 1984 to promote and coordinate efforts for the evaluation and cleanup of contamination at Department of Defense installations. On January 23, 1987, Presidential Executive Order 12580 was issued which assigned the responsibility to the Secretary of Defense for carrying out DERP within the overall framework of the Superfund Amendments and Reauthorization Act (SARA) and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The IRP was established under DERP to identify, investigate, and cleanup contamination at installations. The IRP focuses on cleanup of contamination associated with past Department of Defense activities to ensure that threats to public health are eliminated and to restore natural resources for future use.

The IRP is divided into six phases, as illustrated on Figure 1-2. These phases are defined and described in the following subsections.

1.2.1 Preliminary Assessment (PA)

The PA process consists of personnel interviews, a record search, and site inspection designed to identify and evaluate past disposal and/or spill sites that might pose a potential or actual hazard to public health, public welfare, or the environment. Previously undocumented information is obtained through the interviews. The record search focuses on obtaining useful information from: aerial photographs, installation plans; facility inventory documents; lists of hazardous materials used; subcontractor reports; correspondence; Material Safety Data Sheets; Federal/State agency scientific reports on endangered and threatened species; and critical habitats, documents from local government offices, and numerous standard reference sources.

1.2.2 Site Investigation (SI)

The SI phase consists of field activities designed to confirm the presence or absence of contamination at the identified site and to determine potential risks to human health and the environment. The activities undertaken during the SI generally fall into three distinct categories: screening, confirmation, and optional activities. Screening activities are conducted to gather preliminary data on each site. Confirmation activities include specific media sampling and laboratory analysis to confirm either the presence or the absence of contamination, chemical concentrations, and the potential for

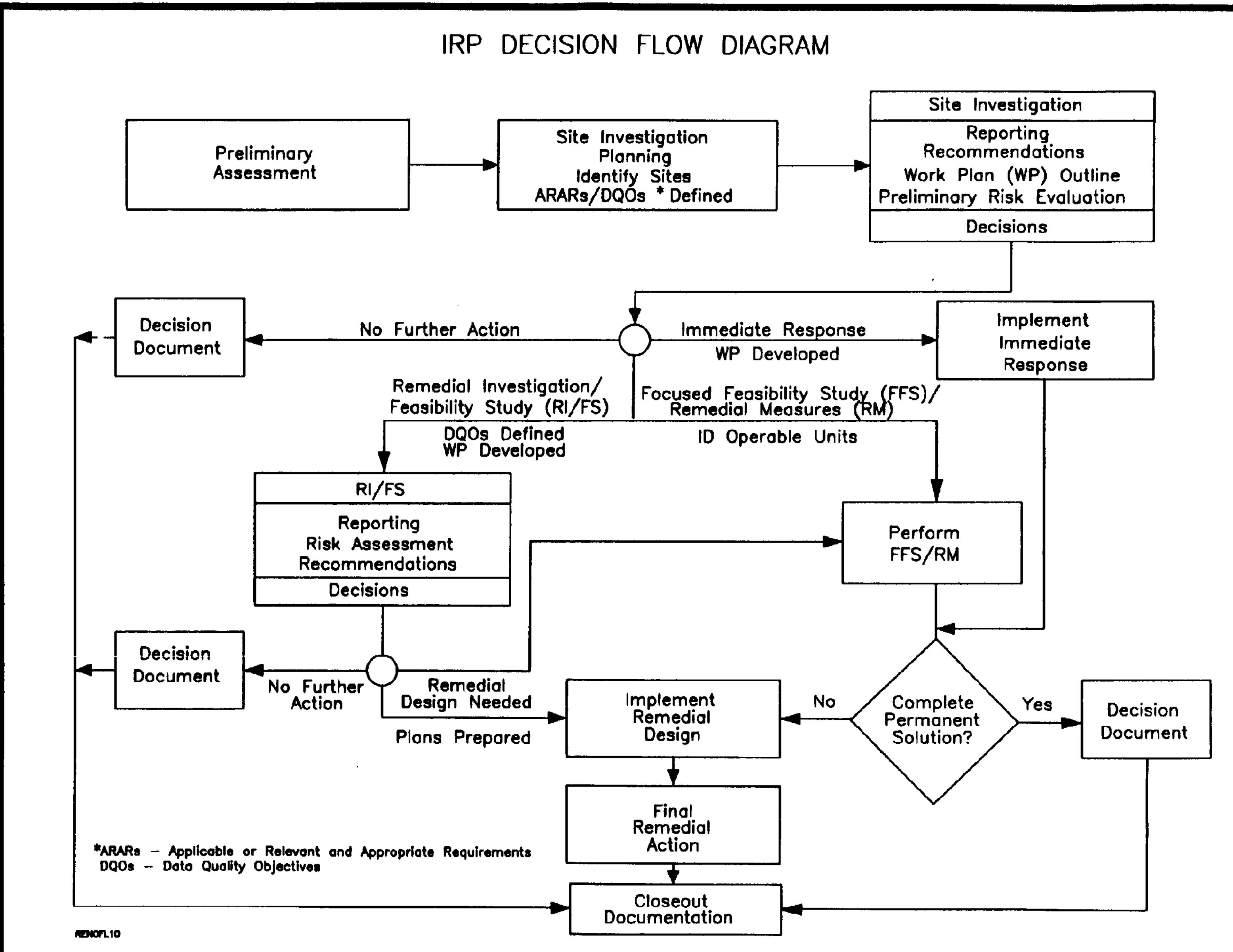

FIGURE 1-2

INSTALLATION RESTORATION PROGRAM
DECISION FLOW DIAGRAM
143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

migration of contaminants. Information obtained during the subsurface investigation is also utilized to define the installation and site hydrology, geology, and soil characteristics. Additional data may be needed to reach a decision point for a site, such as no further IRP action warranted, prompt removal of contaminants is necessitated, or further IRP work is required.

The general approach for the design of the SI is to sequence the field activities so that data are acquired and used as the field investigation progresses. This is done in order to determine the absence or presence of contamination in a relatively short period of time, optimize data collection and data quality, and to keep costs to a minimum.

1.2.3 Remedial Investigation (RI)

The objectives of the RI are to determine the nature and extent of contamination at a site, determine the nature and extent of the threat to human health and the environment, and provide a basis for determining the types of response actions to be considered (decision document, FS, remedial design, or remedial action).

The RI consists of field activities designed to quantify the potential contaminant, the extent of the contamination, and the pathways of contaminant migration. Field activities may include the installation of soil borings and/or monitoring wells, and the collection and analysis of water, soil, and/or sediment samples. Careful documentation and quality control procedures are implemented during RI field activities in accordance with CERCLA/SARA guidelines which ensure the validity of data.

Hydrogeologic studies are conducted to determine the underlying strata, groundwater flow rates, and direction of contaminant migration.

A baseline risk assessment is conducted which provides an evaluation of the potential threat to human health in the absence of remedial action. The risk assessment provides the basis for determining whether remedial action is necessary and mitigates endangerment to public health or the environment.

The findings from this study result in the selection of one of the following options:

- No Further Action: The results of investigations do not indicate harmful concentrations of chemicals that pose a significant threat to human health or the environment. Therefore, no further IRP action is warranted and a decision document will be prepared to close the site.

- Long-Term Monitoring (LTM): The results of investigations do not indicate the presence of sufficient contamination to justify costly remedial action. LTM may be recommended to detect the possibility of future problems.

- FS: The results of investigations confirm the presence of contamination that may pose a threat to human health and/or the environment, and some sort of remedial action is indicated. The FS is described fully in the following subsection.

1.2.4 Feasibility Study (FS)

Based on results of the RI, the baseline risk assessment, and a review of State and Federal regulatory requirements, an FS will be prepared to develop, screen, and evaluate alternatives for remediation of groundwater and/or soil contamination at the site. The overall objectives of the FS include providing information necessary for remedial alternative development and evaluation to support the selection of a remedy that is protective of human health and the environment; considering applicable or relevant and appropriate requirements (ARARs); satisfying the preference for a treatment that significantly and permanently reduces toxicity, mobility, or volume of hazardous constituents as a principal element; and maximizing cost-effectiveness.

Activities associated with the FS include the following:

- Development of alternatives;

- Preliminary screening of alternatives;

- Detailed analysis of alternatives;

- Comparative analysis of alternatives; and

- Completion of an FS report.

The end result of the FS is the selection of the most appropriate remedial action with concurrence by State and/or Federal regulatory agencies.

1.2.5 Remedial Design (RD)

The RD involves the formulation and approval of the engineering designs required to implement the selected remedial action identified in the FS.

1.2.6 Remedial Action (RA)

The RA is the actual implementation of the remedial alternative. It refers to the accomplishment of measures to eliminate the hazard or, at a minimum, to reduce it to an acceptable limit. Covering a landfill with an impermeable cap, pumping and treating contaminated groundwater, installing a new water distribution system, and in situ biodegradation of contaminated soils are examples of remedial measures that might be selected. In some cases, after the RAs have been completed, an LTM system may be installed as a precautionary measure to detect contaminant migration or to document the efficiency of remediation.

1.2.7 Immediate Action Alternatives

At any point, it may be determined that a site poses an immediate threat to public health or the environment, thus necessitating prompt removal of the contaminants. Immediate action, such as limiting access to the site, capping or removing contaminated soils, and/or providing an alternative water supply may suffice as effective control measures. Sites requiring immediate removal action maintain IRP status in order to determine the need for additional remedial planning or LTM. Removal measures or other appropriate remedial actions may be implemented during any phase of an IRP project.

1.3 General Investigation Approach

Eleven soil borings, 10 surface soil samples, 22 Geoprobe™/ Hydropunch™ groundwater samples, and five groundwater monitoring wells will be installed during RI field activities. Two soil samples from each boring and four rounds of groundwater samples from each groundwater monitoring well will be collected for laboratory analysis. Two sediment samples will be collected from an on-Station storm sewer. Sampling rounds for monitoring wells will be 3 months apart. The Geoprobe™/Hydropunch™ groundwater samples will be collected for on-site analysis using a mobile laboratory.

Four rounds of groundwater samples and water level elevation measurements will also be collected from each of the existing SI groundwater monitoring wells at Seattle ANGS. The first round will be performed as part of the field setup prior to drilling activities. The other three rounds will be collected during the sampling of the RI-installed wells.

One slug test will be performed in order to characterize hydraulic characteristics at Seattle ANGS. Groundwater monitoring wells installed during the RI will be utilized for the slug test.

1.4 Work Plan Structure

This RI/FS Work Plan provides a description of the activities for the RI/FS and is organized into 19 sections and five appendices. The contents of the sections are as follows:

- Section 1.0 provides general introductory information for this work plan.
- Section 2.0 describes the project management approach.
- Section 3.0 provides background information for the Seattle ANGS.
- Section 4.0 summarizes environmental setting data for the vicinity of the Seattle ANGS.
- Section 5.0 describes permits required to perform RI field tasks.
- Section 6.0 outlines the RI investigative approach.
- Section 7.0 describes field investigative methods and procedures.
- Section 8.0 describes sample collection procedures.
- Section 9.0 summarizes applicable or relevant and appropriate requirements.
- Section 10.0 describes data requirements and objectives to determine contaminant fate and transport.
- Section 11.0 describes the data requirements and objectives of the baseline risk assessment.
- Section 12.0 discusses the key elements of the FS.

- Section 13.0 describes equipment decontamination procedures.
- Section 14.0 describes borehole abandonment procedures.
- Section 15.0 describes investigation derived waste handling procedures.
- Section 16.0 outlines project schedule and deliverables.
- Section 17.0 describes the purpose and format for the RI Report.
- Section 18.0 describes the purpose and format for the FS Report.
- Section 19.0 lists references cited in this work plan.

The following five appendices are included in this work plan:

- Appendix A contains the Sitewide Safety and Health Plan (SSHP).
- Appendix B contains results of a regulatory file review and an environmental database report.
- Appendix C contains the State of Washington's Risk Assessment Methodologies and published information regarding background concentrations of trace metals in State of Washington soils.
- Appendix D includes the Quality Assurance Project Plan (QAPP).
- Appendix E includes sample outlines for the RI and FS Reports, as provided by ANG/CEVR.

SECTION 2.0

PROJECT MANAGEMENT APPROACH

The successful execution of this RI/FS lies in a strong, qualified project team. Accordingly, ERM will utilize an experienced team of professionals who have previously performed similar work at other investigation sites. The project team will be selected by the Program Manager and the names and qualifications of the project team will be submitted to the ANG/CEVR Project/Site Manager upon request.

2.1 Project Management Organization

The project will be managed and executed by personnel selected by ERM who will ensure that the objectives of the RI/FS are met. Figure 2-1 provides an organization chart for this project. The chart includes the names of key management personnel assigned to the Seattle ANGS RI/FS project.

The drilling and well installation, analytical services, and surveying support will be provided by experienced subcontractor firms that possess the required permits, licenses, and accreditation's necessary to work in the State of Washington.

ERM's project team will consist of the key positions below.

Program Manager: Responsible for the overall execution of this project and for maintaining an open line of communication with the ANG/CEVR Project Manager.

Project/Site Manager: Directly supervises the project team, provides technical direction and interface with ANG/CEVR, directs field operations, and coordinates contractor and subcontractor support.

Site Manager: Assigned when the Project/Site Manager is not on site. The Site Manager will be responsible for directly supervising the field investigation project team and providing technical direction and technical interface with the Project/Site Manager.

Quality Assurance/Quality Control (QA/QC) Manager: Responsible for developing standardized QA procedures for this project and for

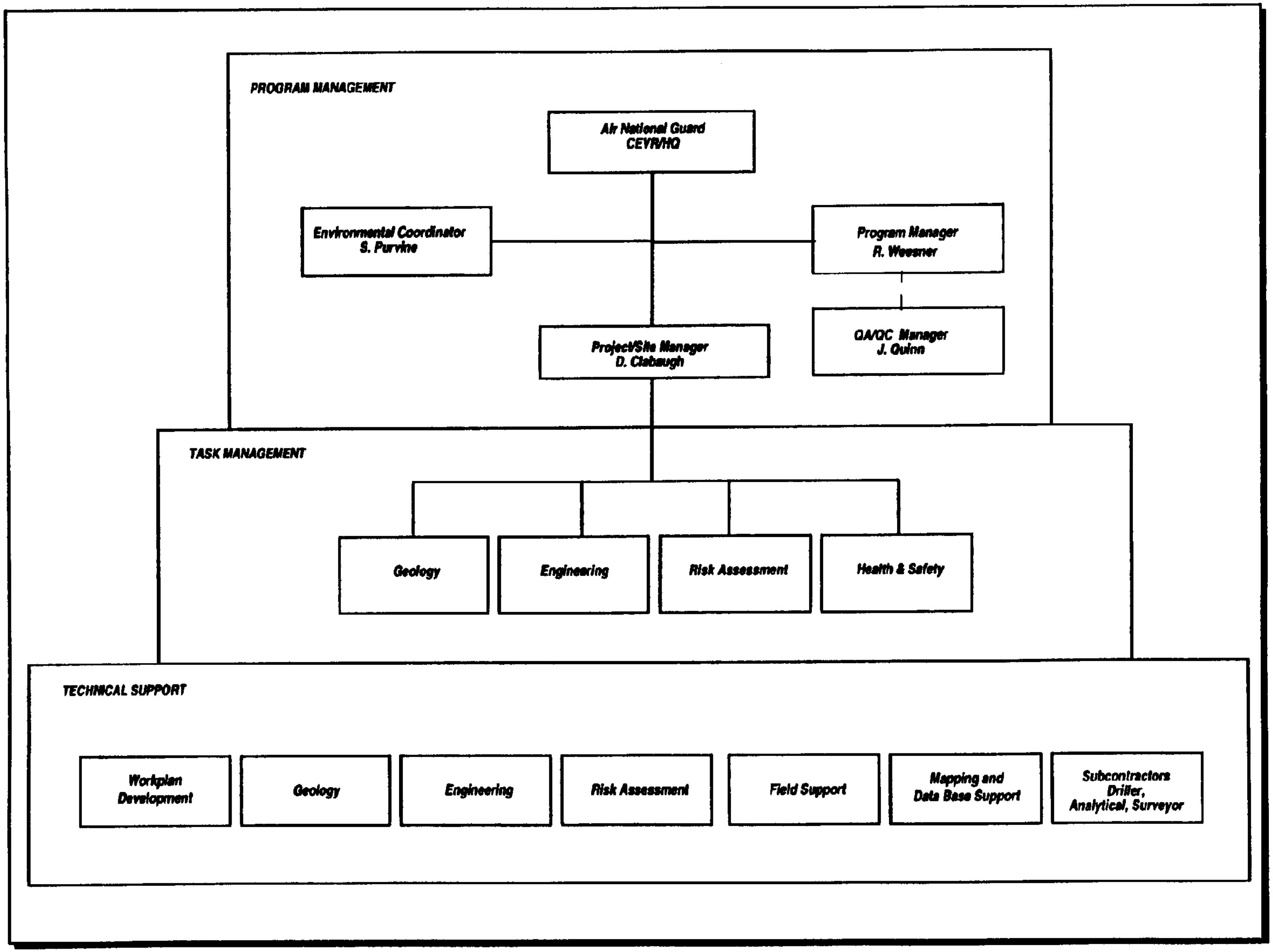

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Figure 2-1
Seattle ANGS RI/FS Project Organization
143rd CCSQ, Seattle ANGS, Seattle, Washington

ensuring that effective procedures and controls are implemented to achieve a high level of project accuracy.

Safety and Health Manager: Responsible for assuring that physical and chemical hazards will be appropriately mitigated through effective execution of the SSHP.

Project Scientists and Engineers: Includes qualified geologists, engineers, and chemists.

2.2 Project Procedures

An open line of communication will be maintained between the Project/Site Manager and the project team to ensure that all of the objectives are met. All sampling activities will be carried out in accordance with this work plan. The overall RI/FS project will be executed within the time frame of the planned project schedule included in this work plan.

2.3 Quality Management

The QA/QC Manager will be responsible for ensuring that all QC procedures are followed. Immediate corrective actions will be taken at any time they are deemed necessary. All QC procedures will be directed in accordance with the QAPP which is included as Appendix D of this work plan.

2.4 Subcontractor Management

ERM is responsible for the performance of all work under this contract delivery order, including the work of subcontractors. ERM will hire subcontractors for drilling, analytical services, and surveying support. ERM's Project/Site Manager will maintain oversight of the subcontractors' completion of specified tasks with respect to technical performance, quality, and adherence to cost and schedule.

All subcontractor activity will be in compliance with the applicable QAPPs and SSHP prepared for this RI/FS. ERM's subcontractors will be notified that it is their responsibility to implement the SSHP.

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SECTION 3.0

FACILITY BACKGROUND INFORMATION

This section of the RI/FS Work Plan includes the following:

- Facility description;
- Site Description;
- Summary of Waste Disposal History;
- Summary of previous investigations at Seattle ANGS; and
- Review of PA/SI Trace Metal Data.

Information presented in this section was derived primarily from Operational Technologies Corporation's (OpTech's) report entitled *Preliminary Assessment/Site Inspection Report, Volume 1, 143rd Combat Communications Squadron, Seattle Air National Guard Station, Washington Air National Guard, Seattle, Washington* (March 1995). Additional information presented in this section was collected during the development of this work plan.

3.1 Facility Description

The Seattle ANGS is at 6736 Ellis Avenue South in Seattle, Washington. The Station presently occupies approximately 7.5 acres of land in the northwest portion of the King County International Airport (Boeing Field) and employs 158 military personnel, of which 24 are full-time employees (OpTech, 1995).

3.2 Site Description

The following sections summarize the history of the Seattle ANGS and describe adjacent land use.

3.2.1 Seattle ANGS History

The Seattle ANGS was built during World War II by the War Department and was used by the Army Air Force as the "Aircraft Factory School" during the war. In 1948, the property was given to King County as surplus property and was subsequently leased to the Washington Air National Guard (OpTech, 1995).

On April 21, 1948, the 143rd Aircraft Control and Warning Squadron was established. From May 1951 to February 1953, the 143rd was activated for recruitment purposes. During this period of time, the unit had two C-47 aircraft. In 1960, the name of the unit was formally changed to the 143rd Communications Squadron Tributary Teams. In 1969 and 1988, the name of the unit was again changed, becoming the 143rd Mobile Communications Squadron and the 143rd CCSQ, respectively. The current mission of the 143rd CCSQ is to provide mobile communication support and telephone/teletype support for airports and airfields (OpTech, 1995).

In 1948, the station consisted of 17 acres of land, including an aircraft parking ramp, leased from King County. At that time, the property contained 15 buildings (including a number of small shed structures), all of which were subsequently demolished. No site plans or photographs depicting these buildings or the general station layout are available. In 1951, a new property lease decreased the size of the station from 17 acres to its present size of 7.5 acres. Buildings were constructed for headquarters, a mess hall, warehouses, and vehicle service requirements. In 1980, the National Guard Bureau approved and Congress funded $2.3 million for the replacement of all buildings. The buildings were completed in 1984, with the exception of the Mobility Warehouse, which was completed in 1988. Seattle ANGS now consists of 7.5 acres and four buildings (34,698 total square feet). The Seattle ANGS property is leased from King County by the United States Air Force, who in turn licenses the property to the Washington State Military Department for Air National Guard use (OpTech, 1995).

3.2.2 Adjacent Land Use

The adjacent properties on three sides of Seattle ANGS are zoned for general industrial use, are currently used for industrial purposes, and have a history of industrial use. The properties directly east, southeast, and southwest of the station are either owned by the Boeing Company (Boeing) or leased by Boeing from King County. The property immediately north of the station is utilized by several large trucking firms and the State of Washington auto maintenance facility, while the area west/northwest of the station, across Ellis Avenue South, consists of residential properties (OpTech, 1995).

3.3 Waste Disposal History

The following subsections describe the hazardous materials/wastes generated, disposal practices, and past environmental incidents and problems at Seattle ANGS.

3.3.1 Wastes Generated by Station Operations

Operational activities at Seattle ANGS generate waste oils, cleaning solvents, paint wastes, and thinners. These wastes are generated by AGE/Motor Vehicle Maintenance, Power Production, and Communication/Administration Buildings.

3.3.2 Disposal Practices at Installation

Presently, hazardous wastes are collected and disposed of by a contractor or through the Defense Reutilization and Marketing Office at Fort Lewis, Washington. Previous disposal practices included land disposal within IRP Site 1 - Burial Site and off-site disposal.

3.3.3 Past Environmental Incidents and Problems

Small amounts of hazardous materials have been spilled or released into the environment at the station in the past. The PA identified IRP Site 1 - Burial Site as the only potentially contaminated disposal site at the Station. Identification of this site was based on interviews with past and present employees, an analysis of pertinent information and Station records, and a field survey. A more detailed description of disposal incidents at the site pertinent to this RI/FS investigation is provided in Section 3.2.5 of this work plan.

3.3.4 Regulatory Records Review

OpTech (1995) identified several sites on properties adjacent to Seattle ANGS with a history of environmental contamination or environmental incidents. ERM further evaluated the environmental conditions at adjacent properties during preparation of this work plan.

The first phase of ERM's evaluation of environmental conditions included an environmental database search. ERM contracted with Environmental Data Resources, Inc., (EDR) to provide a report on the status and location of sites of environmental significance within a 1-mile radius of Seattle ANGS. EDR prepared a summary report based on the results of the database search (Appendix B). The EDR database identified 19 sites within a 1-mile radius of Seattle ANGS that appear on the Washington Department of Ecology's (WDOE's) Confirmed and Suspected Contaminated Sites List. The EDR database also identified 14 leaking underground storage tank sites within one-half mile of Seattle ANGS. EDR also identified one sensitive receptor category, a day care center, within a one-quarter mile radius of the Seattle ANGS.

The second phase of the regulatory records review included a review of WDOE's file records regarding selected sites of environmental concern. These sites of environmental concern include the following:

- Boeing Company - North Field, Ellis Avenue South & Marginal Way
- King County Airport Maintenance, 6518 Ellis Avenue South
- Washington State Motor Pool, 6650 Ellis Avenue South
- Seattle City Light - Georgetown Steamplant, 1131 South Elizabeth Street
- A & T Pump, 6525 Ellis Avenue South

More than one site of environmental concern exists within the Boeing Company North Field property. The locations of these sites with reference to Seattle ANGS are illustrated on Figure 3-1. The following subsections summarize the results of ERM's file review. Table 3-1 presents an overall summary of the results of ERM's file review. A more detailed description of ERM's findings are included in Appendix B.

3.3.5 IRP Site 1 - Burial Site Description

The following is a description of IRP Site 1 - Burial Site, including past uses and release history of the site. The description is excerpted from the PA/SI Report (OpTech, 1995).

TABLE 3-1

Summary of Findings for Adjacent Sites of Environmental Significance
143rd CCSQ, Seattle ANGS, Seattle, Washington

Site Name	Distance From Seattle ANGS	Affected Media			Contaminants of Concern	Detected on ANGS Site?(1)	Possible Impacts to Seattle ANGS
		Soil	GW	SW			
Boeing Company - Fire Training Center	800 feet	R R -	S S C	- - -	Petroleum hydrocarbons Skydrol(TM) Arsenic	Yes - Soil No No	Possible groundwater quality impacts, Seattle ANGS directly downgradient of site
Boeing Company - Storm Sewer PCBs	Adjacent	-	-	R(2)	PCBs	No	Possible PCBs in storm sewer sediments
Boeing Company - Green Hornet Area	670 feet	D	D	-	Petroleum hydrocarbons	Yes - Soil	Possible groundwater quality impacts
Boeing Company - F & G Facility	Adjacent	R	R	-	Petroleum hydrocarbons	Yes - Soil	Possible groundwater quality impacts
Boeing Company - Building 3-354	680 feet	C	S	-	Petroleum hydrocarbons	Yes - Soil	No significant impact expected
Boeing Company - Building 3-360/361/365	Adjacent	- -	C C	- -	Petroleum hydrocarbons Trichloroethylene	Yes - Soil No	Possible groundwater and soil quality impacts related to undefined sources of groundwater contamination at this site
Boeing Company - Building 7-027-1/2/3	680 feet	-	C	-	Petroleum hydrocarbons Trichloroethane	Yes - Soil No	No significant impact expected
Boeing Company - Utilidor Project	280 feet	C	C	-	Petroleum hydrocarbons	Yes - Soil	No significant impact expected
Boeing Company - Building 3-800	1,750 feet	C C -	C C C	- - -	CVOCs Beryllium Metals (As, Cr, Pb)	No Yes -Soil No	No significant impact expected
Boeing Company - Building 3-801	1,850 feet	D -	- C	- -	Petroleum hydrocarbons Metals (Sb, As, Cr, Pb)	Yes - Soil No	No significant impact expected
Boeing Company - Flight Line Utility	2,350 feet	R	S	-	Petroleum hydrocarbons	Yes - Soil	No significant impact expected
Boeing Company - Main Fuel Farm	2,350 feet	D	C	-	Petroleum hydrocarbons	Yes - Soil	No significant impact expected
King County Airport Maintenance	500 feet	R	C	-	Petroleum hydrocarbons	Yes - Soil	No significant impact expected
Washington State Motor Pool	450 feet	R	S	-	Petroleum hydrocarbons	Yes - Soil	Possible groundwater quality impacts
Seattle City Light - Georgetown Steamplant	Adjacent	R D	- S	R (2) -	PCBs Petroleum hydrocarbons	No Yes - Soil	Possible PCBs in storm sewer sediments, possible petroleum hydrocarbon impacts to GW and soil
A & T Pump	250 feet	C	S	-	Petroleum hydrocarbons	Yes - Soil	No significant impact expected

Notes:
1. Contaminants of concern detected on the Seattle ANGS site at concentrations greater than established cleanup levels are included.
2. Storm sewer sediments were the contaminated medium.

GW = Groundwater
SW = Surface Water
S = Contamination suspected
C = Contamination confirmed but extent not adequately defined
D = Contamination extent defined
R = Contamination remediated to <MTCA Method A cleanup levels
- = No suspected or confirmed contamination
PBCs = Polychlorinated biphenyls
CVOCs =Chlorinated volatile organic compounds

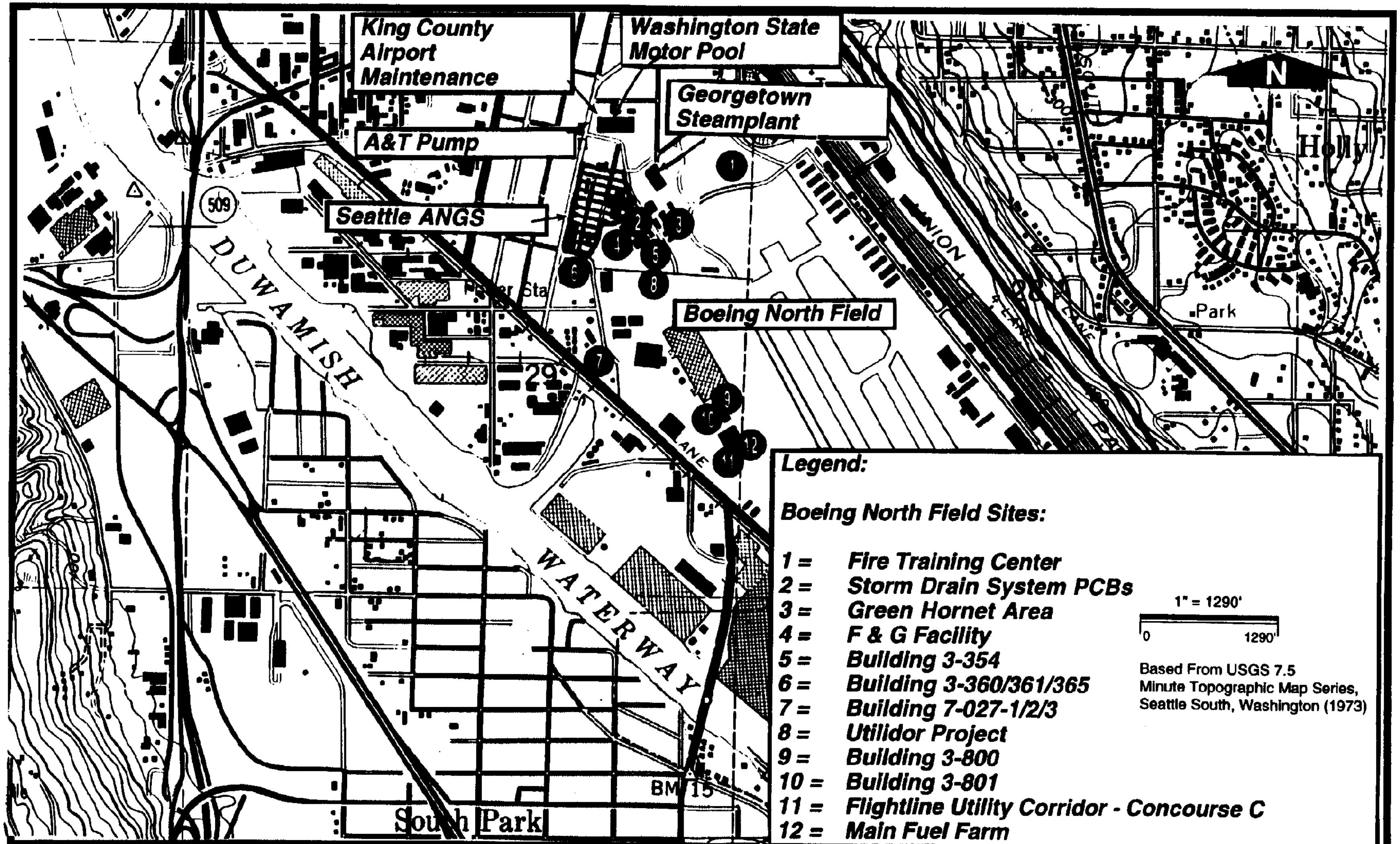

FIGURE 3-1

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POTENTIAL OFF-SITE CONTAMINATION SOURCES

143rd CCSQ, Seattle, ANGS
Seattle, Washington

ERM

3.3.5.1 Description

IRP Site 1 - Burial Site is located in the northeast corner of Seattle ANGS. The site is approximately 150 feet long and an average of 150 feet wide. The north and east sides of the site are bound by a 6-foot-high fence. With the exception of the grass-covered northeast corner, the site is covered with asphalt and is used as a vehicle parking area.

3.3.5.2 Release History

A variety of waste items were burned and/or buried at IRP Site 1 - Burial Site from the early 1950s through 1968. The wastes most likely disposed of at this site included radio tubes; solvents; waste motor oils; kerosene; batteries; brake fluid; spray paints; paint thinners or removers; methyl, ethyl, ketone; xylene; and naptha.

3.4 Previous Investigations

The following subsection summarizes previous investigations conducted at the Seattle ANGS pertinent to this RI/FS.

3.4.1 Installation Restoration Program

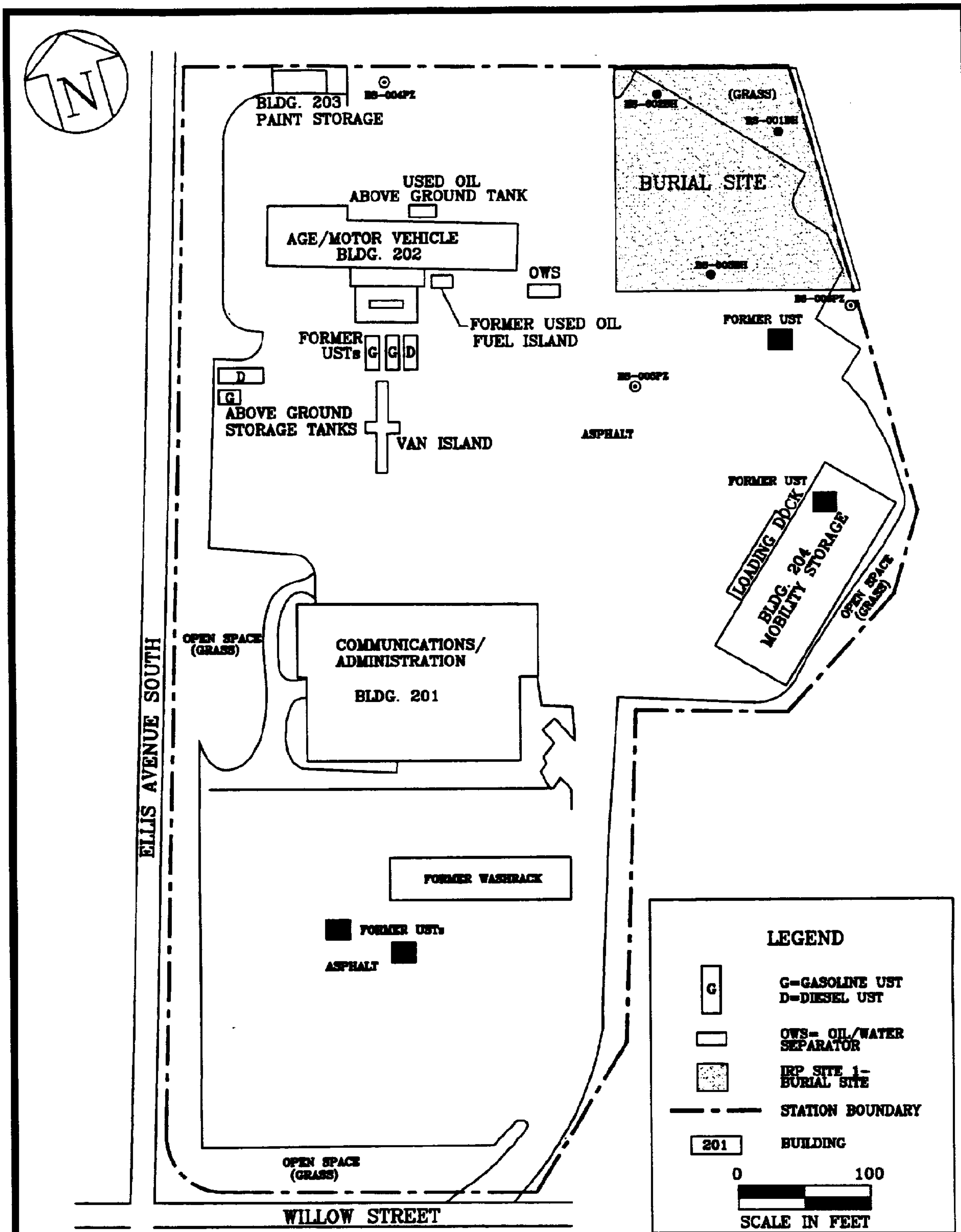
The following is a summary of the PA and SI conducted at Seattle ANGS.

3.4.1.1 Preliminary Assessment

A Draft PA for the Seattle ANGS was completed by ANG in December 1993. The PA focused on past and present generation, use, handling, and disposal practices of hazardous waste and materials. Based on the results of the PA, IRP Site 1 - Burial Site, was identified as being potentially contaminated with hazardous materials/hazardous waste and was recommended for further IRP investigation. The location of IRP Site 1 - Burial Site is shown on Figure 3-2.

3.4.1.2 Preliminary Assessment/Site Investigation

OpTech performed the field work for a PA/SI at Seattle ANGS during July 1994 and completed the PA/SI report in 1995. The SI field work included screening and confirmation activities conducted at IRP Site 1 -



SOURCE: OPTECH, 1995

FIGURE 3-2

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LOCATION OF IRP SITE 1 –
BURIAL SITE

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

Burial Site. The activities performed were as follows:

Screening Activities

- Ground penetrating radar (GPR) survey; and
- Magnetometer survey.
- Shallow soil vapor survey at 21 sampling locations;

Confirmation Activities

- Soil sampling from three soil borings and one piezometer boring; and
- Installation and groundwater sampling at three piezometers.

The following sections summarize the scope of work, the results of geologic and hydrologic investigations, and the results of laboratory analyses conducted by OpTech. Figure 3-3 shows the locations of soil borings and monitoring wells installed during the PI.

Scope of Work. As stated by OpTech (1995), the purpose of the PA/SI was to identify potential areas of concern through PA activities and to confirm or deny the presence of soil and groundwater contamination associated with past hazardous material and hazardous waste handling and disposal through SI activities. The scope of the PA/SI was limited to areas under the primary control of Seattle ANGS. In addition, the PA/SI did not determine the extent of contamination at IRP Site 1 - Burial Site and the extent of possible threats to human health and the environment. Therefore, within these limits, the PA/SI included the following activities: identifying AOCs at or under primary control of ANGS and evaluating potential receptors; defining the nature of releases at the identified AOC; confirming the absence or presence of soil and groundwater contamination; describing the geologic conditions of the installation study area, including the subsurface soil types and presence or absence of hydrogeologic confining layers; and defining hydrogeologic conditions, such as groundwater flow direction.

Geophysical Investigation. A geophysical survey, using GPR and magnetometer investigation techniques was conducted in June 1994 during the PA/SI.

GPR data were collected along 11 vertical and 11 horizontal traverses at IRP Site 1 - Burial Site. The results of the survey revealed subsurface structures and disturbed soil areas. Two underground utilities were detected in the northern and eastern areas of IRP Site 1 - Burial Site

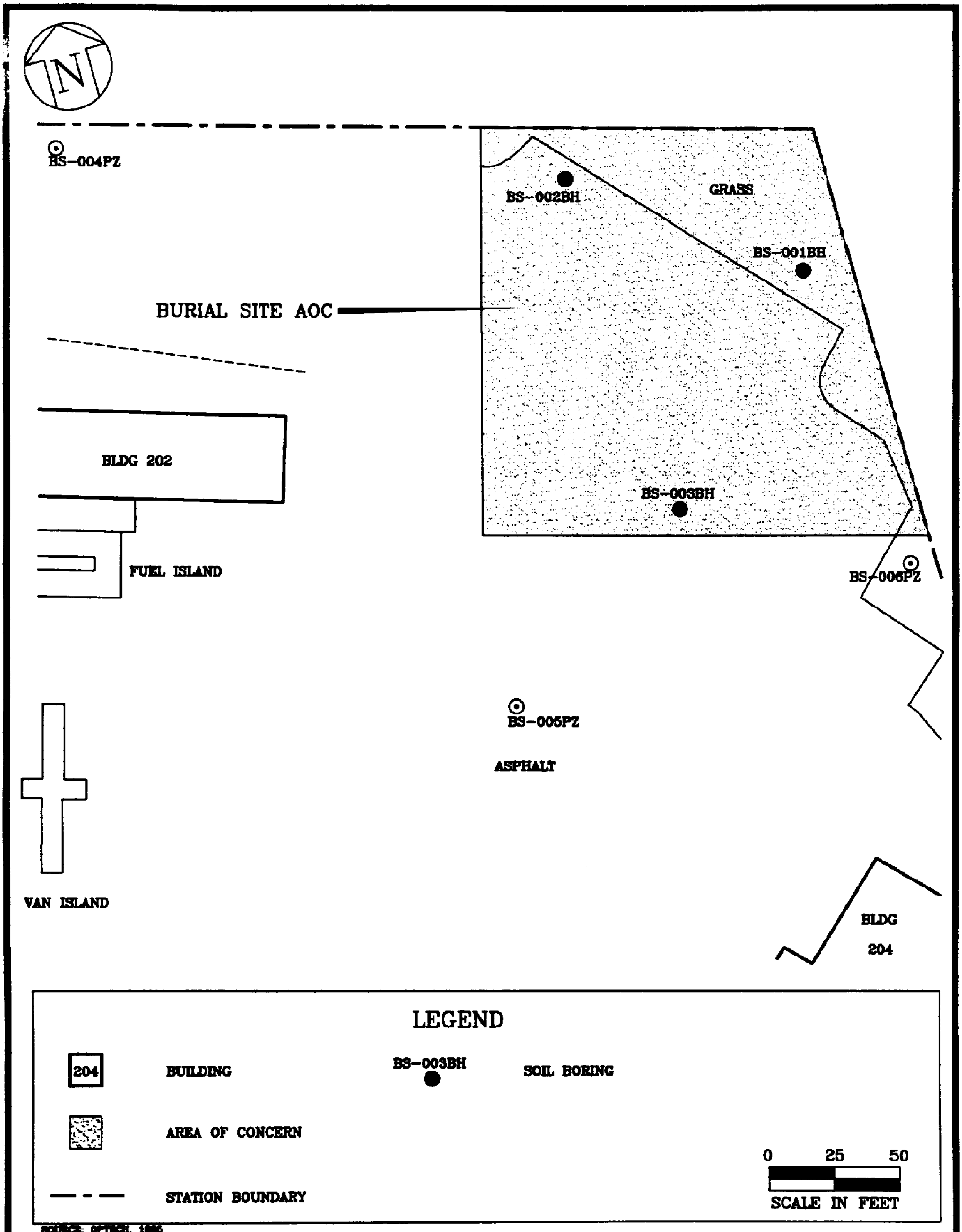

FIGURE 3-3

LOCATION OF PA/SI SOIL BORING AND MONITORING WELLS
143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

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SEA405579

using GPR. The possible presence of these utilities was indicated (by as-built drawings) before the survey was conducted. A large area of a different soil horizon or disturbed soil, with an upper interface at approximately 4.5 to 6.0 feet below ground surface (bgs), was detected on numerous traverses in the southwestern area of IRP Site 1 - Burial Site. The origin of this different soil material was interpreted by OpTech as either being associated with the filling-in of the former Duwamish River or with the burial or burning activities at IRP Site 1 - Burial Site.

OpTech collected magnetometer data at IRP Site 1 - Burial Site. The data indicated the presence of significant magnetic disturbances in specific areas of the site, all of which are attributable to surface interferences. OpTech concluded that there were no significant magnetic disturbances present which coincided with the area of disturbed soil detected with GPR in the southwestern portion of IRP Site 1 - Burial Site. OpTech also concluded that the disturbed soil area is not suspected of being an area where significant metal masses are buried (OpTech, 1995).

Soil Vapor Survey. A soil vapor survey was conducted at IRP Site 1 - Burial Site to confirm or deny the presence of contaminated soil at the site. Twenty-one soil vapor samples were collected on a grid, spacing the points 30 feet apart. All soil vapor samples were collected from approximately 5 feet bgs. Figure 3-4 is an isoconcentration map showing total volatile hydrocarbons detected at IRP Site 1 - Burial Site. The soil vapor survey results were then used to determine the soil boring locations (OpTech, 1995).

Soil Borings. Three soil borings, identified as BS-001BH through BS-003BH, were drilled at IRP Site 1 - Burial Site to approximately 10 feet bgs. The locations of the soil borings were selected based on results of the geophysical and soil vapor surveys. The soil borings were drilled in areas of known past waste dumping, burning, and burial. Three soil samples were collected from each of the soil borings and submitted for laboratory analysis.

Piezometer Installation. Three piezometers, identified as BS-004PZ through BS-006PZ, were installed at Seattle ANGS. Although identified as piezometers, the wells were used for both groundwater level monitoring and groundwater sampling. One piezometer (BS-004PZ) was installed cross-gradient from IRP Site 1 - Burial Site. Piezometers BS-005PZ and BS-006PZ were installed downgradient of the site. The three piezometers were drilled to 20.5 feet bgs.

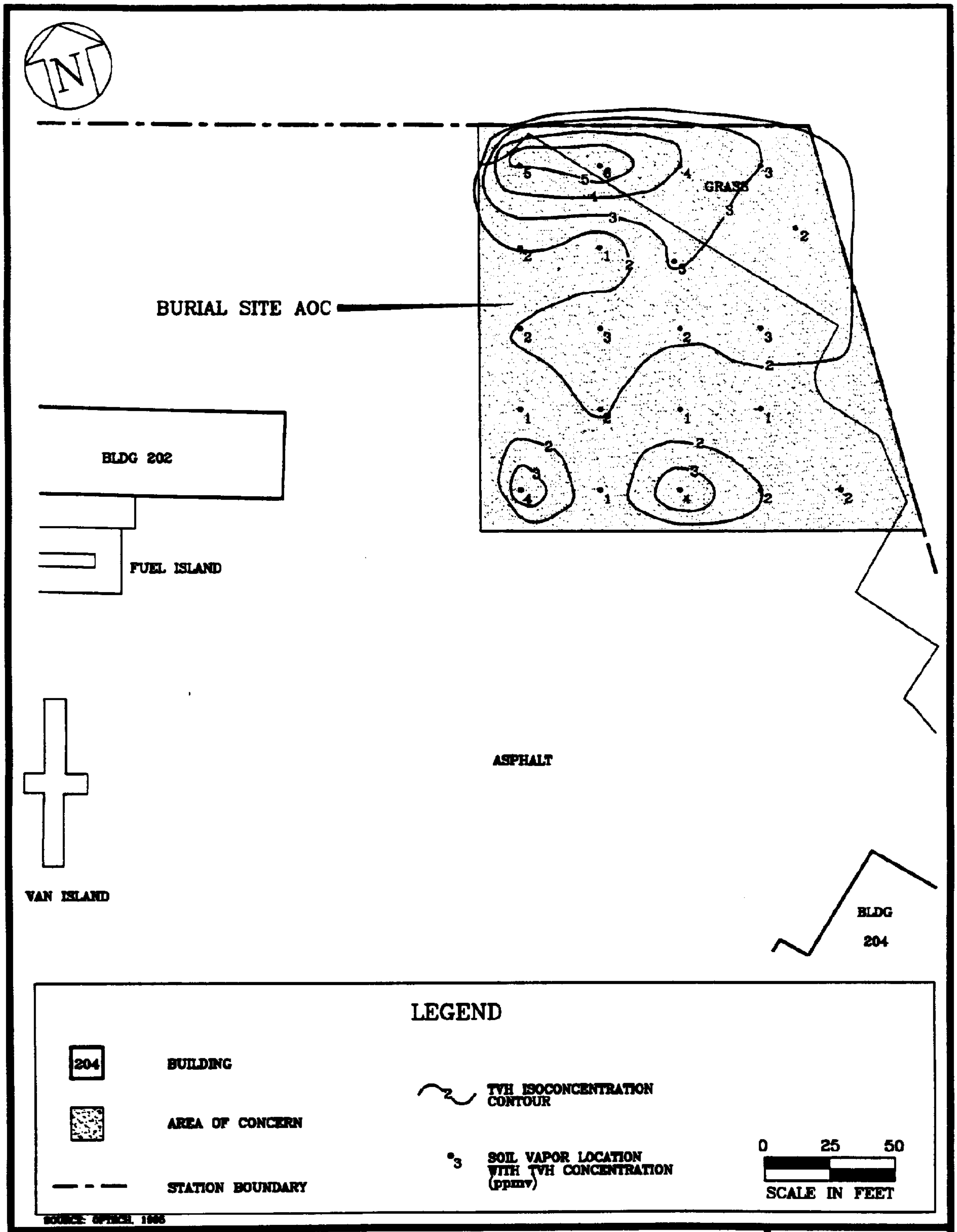

FIGURE 3-4

SOIL VAPOR SURVEY RESULTS
TOTAL VOLATILE HYDROCARBONS (TVH)

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

Soil and groundwater samples collected from piezometer BS-004PZ were used to determine groundwater and background information for the site.

Geologic and Hydrologic Conditions. Soil samples collected from the soil borings and piezometers at IRP Site 1 - Burial Site were used to provide information for describing the subsurface geology and soil conditions in the vicinity of IRP Site 1 - Burial Site. Sand, silty sand, and silty clay were the predominant materials encountered during the drilling activities at IRP Site 1 - Burial Site. A gravel and sand fill material was encountered in the first 1 to 2 feet bgs at all piezometer locations and at boring BS-003BH. At all three piezometer locations, a silty sand was then encountered to 10 feet bgs, followed by a well-sorted, coarse-grained sand from 10 to 20.5 feet bgs. For the three borings, the predominant materials encountered from the surface to 4 feet bgs were a silty sand and clay; a clayey sand; and fill and a clayey sand for borings BS-001BH, BS-002BH, and BS-003BH, respectively. From this depth to 10 feet bgs, silty sand was encountered in all borings, with a clayey sand interval encountered at 5.5 to 7 feet bgs in boring BS-001BH being the only exception. Locations of OpTech's cross-sections depicting the subsurface geology are shown on Figure 3-5. Figures 3-6 and 3-7 present the cross-sections.

OpTech measured static water levels during one sampling event (July 1994) during the SI field work. Depth to water in the three piezometers ranged from about 9.5 to 9.8 feet bgs. OpTech prepared a map showing the piezometric surface based on the static water measurements and determined that groundwater flow direction was toward the southwest (Figure 3-8).

Results of Chemical Analyses. Tables 3-2 and 3-3 summarize the analytical results for soil and groundwater samples collected during OpTech's SI.

Results of chemical analysis for soil samples collected from soil borings drilled at IRP Site 1 - Burial Site indicate the presence of a semivolatile organic compound (SVOC), di-n-butyl phthalate, in all but one sample collected during the SI. OpTech suggested that the presence of di-n-butyl phthalate may be due to laboratory contamination of the soil samples. Total petroleum hydrocarbons (TPH) were detected at concentrations exceeding WDOE action levels in one sample collected from soil boring BS-003BH at 2 feet bgs. Gross alpha and gross beta were detected in one or more soil samples collected from all three soil borings drilled at IRP Site 1 - Burial Site and in groundwater samples collected from all three piezometers. OpTech compared concentrations of trace metals in soil samples collected from IRP Site 1 - Burial Site to

TABLE 3-2

Summary of SI Soil Chemical Quality Data
143rd CCSQ, Seattle ANGS, Seattle, Washington

Borehole Identifier	Sample Depth	Volatile Organic Compounds (EPA Method 8240) (µg/kg)	Semivolatile Organic Compounds (EPA Method 8270) (µg/kg) di-n-butyl phtalate	Total Petroleum Hydrocarbons (WTPH-D, G) (mg/kg)	Polychlorinated Biphenyls (EPA Method 8080) (µg/kg)	Radionuclides (EPA Method 9310) pCi/g Gross Alpha	Radionuclides (EPA Method 9310) pCi/g Gross Beta
Background (BS-004PZ)	8.5 - 10.0	ND	2,240	ND	ND	0 ± 17	0 ± 32
BS-001BH	1.0 - 2.5	ND	1,750	ND	ND	4 ± 27	2 ± 35
	5.5 - 7.0	ND	1,680	ND	ND	0 ± 18	4 ± 36
	8.5 - 10.0	ND	1,590	ND	ND	0 ± 20	0 ± 24
BS-002BH	1.0 - 2.5	ND	1,640	ND	ND	2 ± 25	3 ± 37
	5.5 - 7.0	ND	900	ND	ND	2 ± 25	0 ± 36
	8.5 - 10.0	ND	1,960	ND	ND	2 ± 25	0 ± 34
BS-003BH	2.0 - 3.5	ND	ND	780*	ND	2 ± 20	2 ± 30
	5.5 - 7.0	ND	744	160*	ND	0 ± 21	0 ± 34
	8.5 - 10.0	ND	1,750	ND	ND	0 ± 21	0 ± 34

Borehole Identifier	Sample Depth	Trace Metals (mg/kg) Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper
Background (BS-004PZ)	8.5 - 10.0	ND	2	1.2	1.6	10	40
BS-001BH	1.0 - 2.5	ND	0.33	1	1.6	11	130
	5.5 - 7.0	ND	1.6	0.82	1.1	11	16
	8.5 - 10.0	ND	0.033	0.29	0.66	7.9	9.3
BS-002BH	1.0 - 2.5	ND	2.7	0.87	1.3	10	23
	5.5 - 7.0	ND	1.1	0.49	0.92	14	23
	8.5 - 10.0	ND	0.63	0.34	0.75	9.3	7.5
BS-003BH	2.0 - 3.5	ND	4.1	1	1.3	11	20
	5.5 - 7.0	ND	20	1.1	1.5	15	33
	8.5 - 10.0	ND	3.7	0.58	1	12	14

Borehole Identifier	Sample Depth	Trace Metals (mg/kg) (continued) Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Background (BS-004PZ)	8.5 - 10.0	34	ND	13	ND	ND	0.056	25
BS-001BH	1.0 - 2.5	28	ND	14	0.053	0.18	0.038	19
	5.5 - 7.0	16	ND	5.8	ND	ND	0.03	8.6
	8.5 - 10.0	9.7	ND	5.6	ND	ND	ND	14
BS-002BH	1.0 - 2.5	28	ND	9.3	ND	ND	0.024	31
	5.5 - 7.0	15	ND	6.2	ND	ND	0.054	16
	8.5 - 10.0	10	ND	7.2	ND	ND	ND	20
BS-003BH	2.0 - 3.5	27	ND	8.6	ND	ND	0.053	19
	5.5 - 7.0	62	ND	14	ND	0.042	0.093	40
	8.5 - 10.0	29	ND	8.3	0.11	ND	ND	20

SI = Site Inspection
EPA = Environmental Protection Agency
µg/kg = micrograms per kilogram
mg/kg = milligrams per kilogram
WTPH-D,G = Washington Total Petroleum Hydrocarbons - diesel, gasoline
BS = Burial Site - AOC
PZ = Piezometer
BH = Borehole
ND = Not detected
pCi/g = picoCuries per gram
* = These values were based on analysis for total petroleum hydrocarbons by EPA Method 418.1. The WTPH-D,G yielded ND results.

TABLE 3-3

Summary of SI Groundwater Chemical Quality Data
143rd CCSQ, Seattle ANGS, Seattle, Washington

Well Identifier	Volatile Organic Compounds (EPA Method 8240) (µg/l)	Semivolatile Organic Compounds (EPA Method 8270) (µg/l) di-n-butyl phtalate	Total Petroleum Hydrocarbons (WTPH-D) (mg/l)	Polychlorinated Biphenyls (EPA Method 8080) (µg/l)	Radionuclides (EPA Method 9310) (pCi/l)	
					Gross Alpha	Gross Beta
Background (BS-004PZ)	ND	ND	ND	ND	36 ± 42	78 ± 25
BS-005PZ	ND	ND	ND	ND	15 ± 39	77 ± 24
BS-006PZ	ND	ND	ND	ND	59 ± 59	58 ± 30

Well Identifier	Trace Metals (mg/l)					
	Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper
Background (BS-004PZ)	ND	0.038	0.013	0.0006	0.12	0.29
BS-005PZ	ND	0.028	0.54	ND	0.0052	0.054
BS-006PZ	ND	0.027	0.82	ND	0.097	0.078

Well Identifier	Trace Metals (mg/l) (continued)						
	Lead	Mercury	Nickel	Silver	Selenium	Thallium	Zinc
Background (BS-004PZ)	0.033	ND	0.16	ND	ND	0.0057	0.45
BS-005PZ	0.022	ND	0.031	ND	0.002	ND	ND
BS-006PZ	0.026	ND	0.06	ND	0.0031	ND	ND

SI = Site Inspection
EPA = Environmental Protection Agency
µg/l = micrograms per liter
mg/l = milligrams per liter
WTPH-D = Washington Total Petroleum Hydrocarbons - diesel
BS = Burial Site AOC
PZ = Piezometer
ND = Not detected
pCi/l = picoCuries per liter

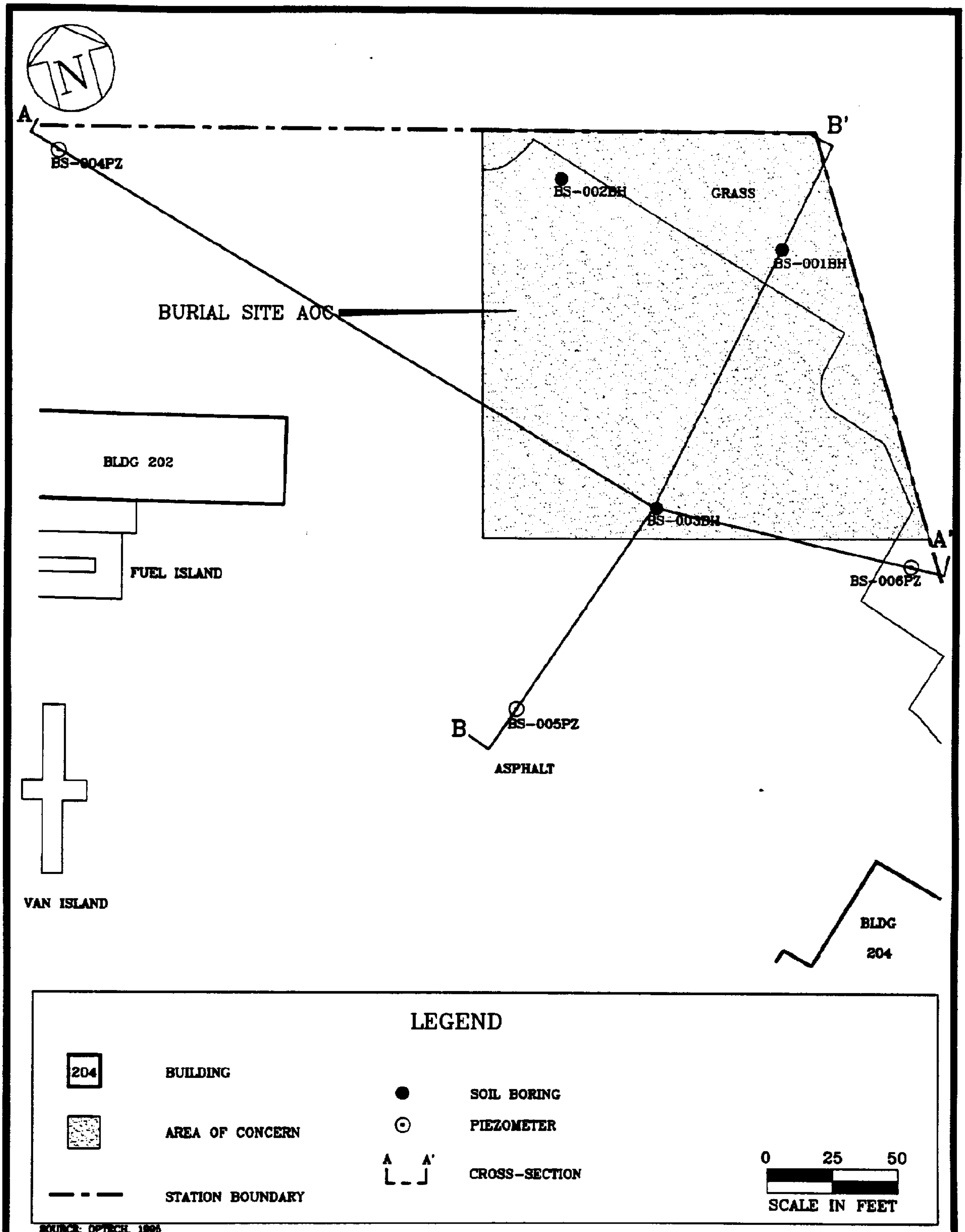

FIGURE 3-5

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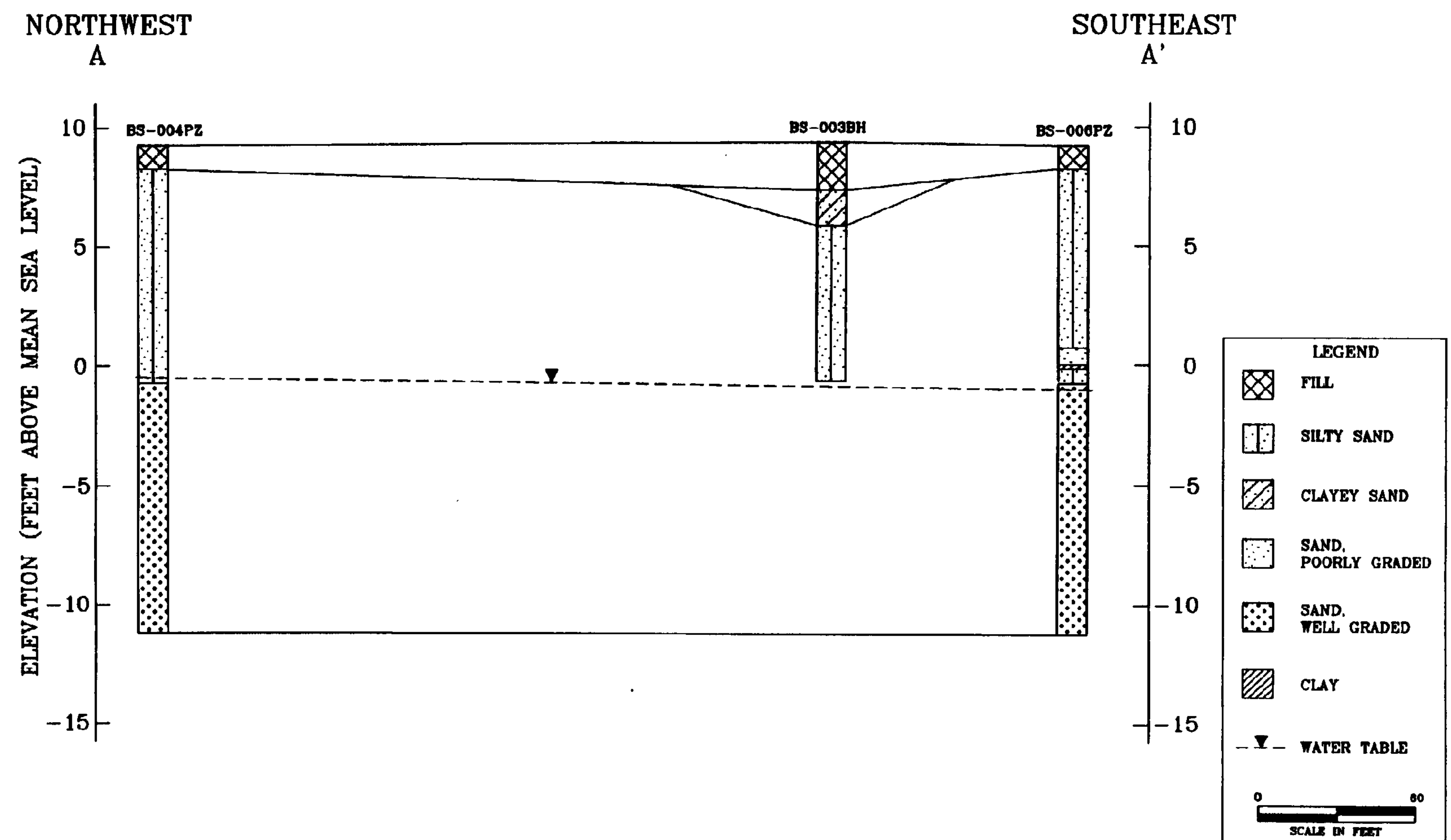
GEOLOGIC CROSS-SECTION
LOCATION MAP

143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM



SOURCE: OPTECH, 1996

FIGURE 3-6

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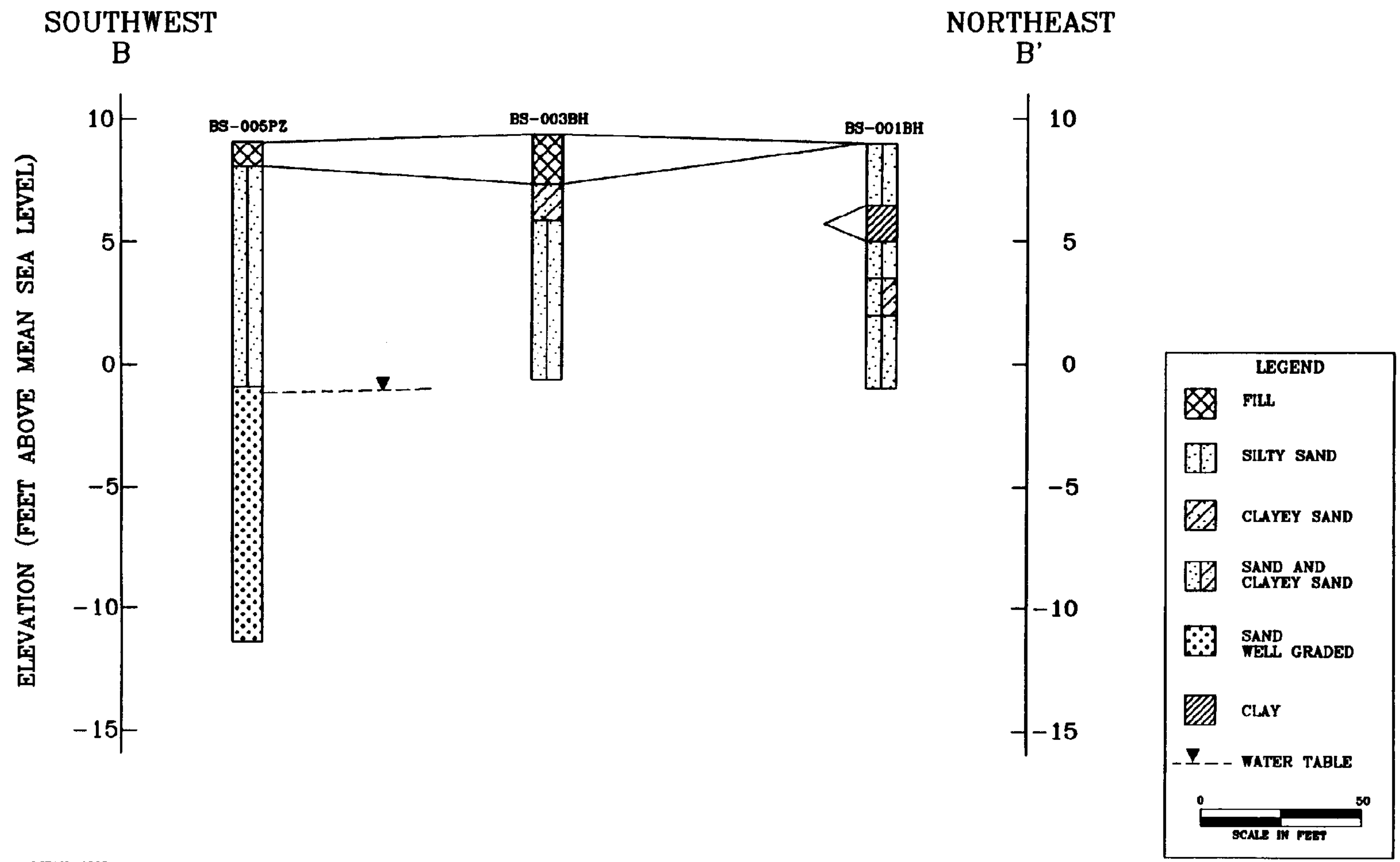
GEOLOGIC CROSS-SECTION A-A'

143rd CCSQ, Seattle ANGS

Seattle, Washington

ERM



SOURCE: OPTECH. 1995

FIGURE 3-7

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GEOLOGIC CROSS-SECTION B-B'

143rd CCSQ, Seattle ANGS

Seattle, Washington

ERM

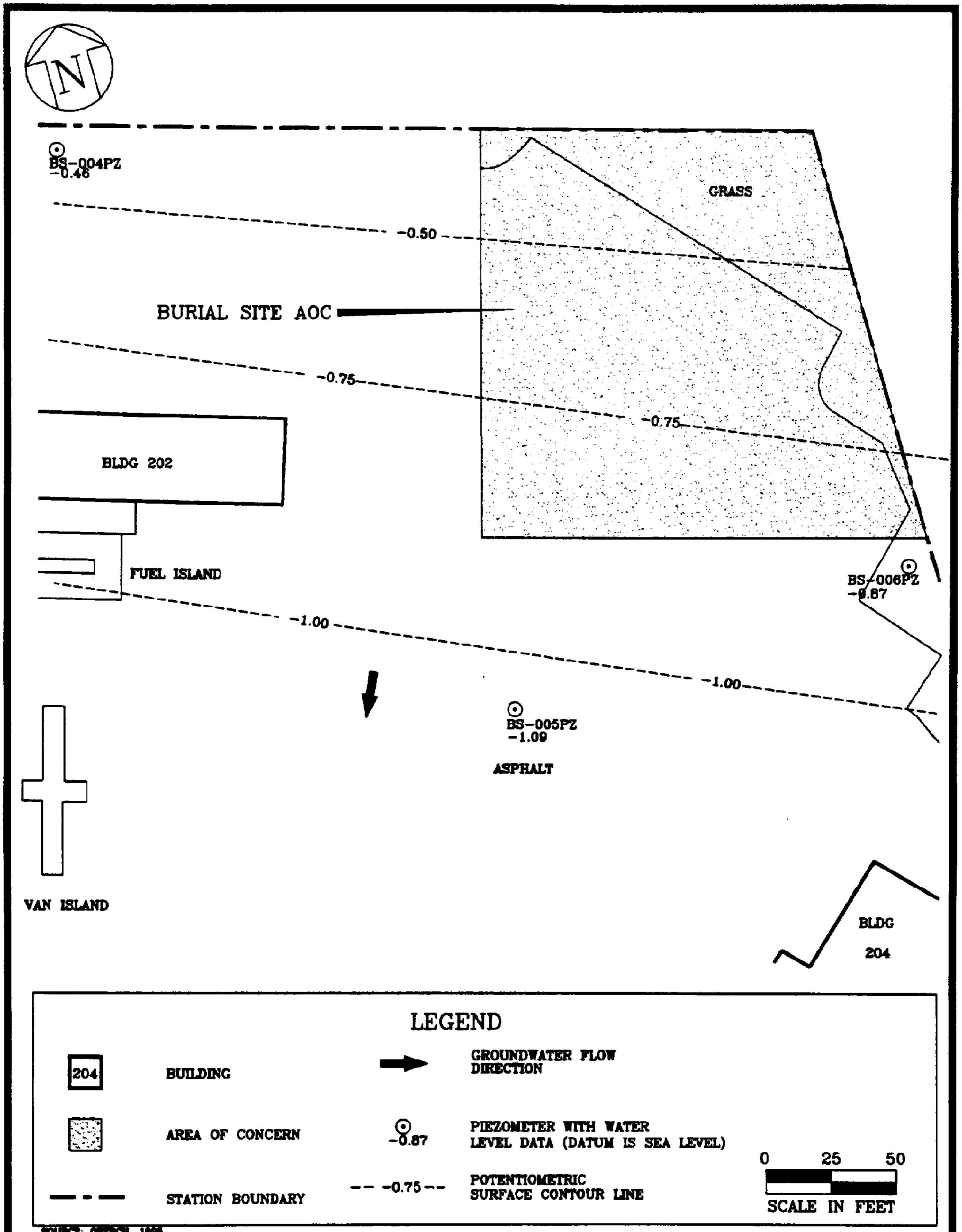

FIGURE 3-8	POTENTIOMETRIC SURFACE, JULY 1994 143rd CCSQ, Seattle ANGS Seattle, Washington	ERM

literature values of background soil concentrations and determined that beryllium concentrations in soil exceeded both background and WDOE action levels.

Conclusions and Recommendations of the PA/SI Report. The PA/SI report recommended that a further investigation be performed at IRP Site 1 - Burial Site to determine the source and areal extent of TPH contamination detected in soil samples collected from borehole BS-003BH and the gross alpha and gross beta radiation detected in soil and groundwater samples. The PA/SI report also noted that State action levels were exceeded for several trace metals, but concentrations did not exceed naturally-occurring concentrations except for beryllium in groundwater.

3.5 Review of PA/SI Trace Metal Data

ERM reviewed OpTech's interpretation of the SI soil and groundwater data using a screening protocol recently established by WDOE. The purpose of the review was to determine whether these trace metals represent impacts to soil and groundwater associated with site activities or represent background concentrations. Table 3-4 summarizes the evaluation of SI Trace Metal Data.

During the PA/SI, nine soil samples collected within IRP Site 1 - Burial Site and one soil sample collected at a background location, yielded detectable concentrations of several trace metals including beryllium, arsenic, copper, lead, and cadmium. Due to its presence across the site at concentrations exceeding WDOE cleanup levels, beryllium is of primary concern. In addition, two groundwater samples collected in the vicinity of IRP Site 1 - Burial Site yielded detectable concentrations of metals including arsenic, beryllium, chromium, and lead.

Screening level background trace metal concentrations have been estimated by WDOE for the region where the site is located (WDOE 94-49, 1995). The 90th percentile values for each regional background data set are calculated by WDOE. For cleanup projects, the 95th upper confidence limit of a site data set is compared to the 90th percentile of the background data set. When comparing individual sample results with the 90th percentile of the background data set:

- No single sample should be greater than two times the 90th percentile value; and
- Less than 10 percent of the site sample concentrations should exceed the 90th percentile value.

TABLE 3-4

Summary of Evaluation of SI Trace Metal Data
143rd CCSQ, Seattle ANGS, Seattle, Washington

Location Number	Sample Depth	Antimony (Sb)	Arsenic (As)	Beryllium (Be)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Thallium (Ti)	Zinc (Zn)
Soil (mg/kg)														
BS-001 BH 1 - 2.5	1.8	ND	0.33	1	1.6	11	130	28	ND	14	0.053	0.18	0.038	19
BS-001 BH 5.5 - 7	6.5	ND	1.6	0.82	1.1	11	16	16	ND	5.8	ND	ND	0.03	8.6
BS-001 BH 8.5 - 10	9.2	ND	0.033	0.29	0.66	7.9	9.3	9.7	ND	5.6	ND	ND	ND	14
BS-002 BH 1 - 2.5	1.8	ND	2.7	0.87	1.3	10	23	28	ND	9.3	ND	ND	0.024	31
BS-002 BH 5.5 - 7	6.5	ND	1.1	0.49	0.92	14	23	15	ND	6.2	ND	ND	0.054	16
BS-002 BH 8.5 - 10	9.2	ND	0.63	0.34	0.75	9.3	7.5	10	ND	7.2	ND	ND	ND	20
BS-003 BH 2 - 3.5	2.8	ND	4.1	1	1.3	11	20	27	ND	8.6	ND	ND	0.053	19
BS-003 BH 5.5 - 7	6.5	ND	20	1.1	1.5	15	33	62	ND	14	ND	0.042	0.093	40
BS-003 BH 8.5 - 10	9.2	ND	3.7	0.58	1	12	14	29	ND	8.3	0.11	ND	ND	20
Determination of Site-Specific WDOE Soil Cleanup Levels														
MTCA A - Indust.			200		10	500		1000	1					
MTCA B*		3.2	1.43	0.233	0.164	400**	2960		24	1600	400	400	5.6	24000
Regional Background - 90th Percentile			7.3	0.61	0.77	48.15	36.36	16.83	0.07	38.19				85.06
No. Samples > Background		NA	1	5	8	0	1	5	0	0	NA	NA	NA	0
Percent Samples > Background		NA	11	56	89	0	11	56	0	0	NA	NA	NA	0
No. of Samples > Cleanup Level***		0	0	5	0	0	0	0	0	0	0	0	0	0
Ground Water (µg/l)														
BS-005 PZ		ND	28	540	ND	5.2	54	22	ND	31	2	ND	ND	ND
BS-006 PZ		ND	27	820	ND	97	78	26	ND	60	3.1	ND	ND	ND
Determination of Site-Specific WDOE Ground Water Cleanup Levels														
MTCA A			5		5	50		5	2					
MTCA B*		6.4	0.05	0.0203	8	8	592		4.8	320	80	80	1.12	4800
ARAR (MCLs)		6	50	4	5	100			2	100		50	2	
No. of Samples > Cleanup Level***		0	2	2	0	1	0	2	0	0	0	0	0	0

Notes:
Soils in milligrams per kilogram
Ground Water in micrograms per liter
MTCA Methd A Industrial values are used. This assumes conditions in WAC 173-340-745 are met.
* MTCA Method B Values - use individual compound estimates for comparison purposes only.
** Assume as worst case that all chromium is chromium (VI)
*** Cleanup level assumed to be the greater of the 90th percentile of background concentration and the Method A/B concentration(s).
Note on compliance - If sample concentration is greater than MTCA A/B, then no single sample concentration shall be greater than two times the 90th percentile value.
Likewise, less than ten percent of the sample concentrations shall exceed the soil cleanup level.

SI = Site Inspection
BS = Burial Site AOC
BH = Borehole
ND = Not detected
WDOE = Washington Department of Ecology
NA = Not available
PZ = Piezometer
ARAR = Applicable or Relevent and Appropriate Requirement
MCLs = Maximum Contaminant Levels
mg/kg = milligrams per kilogram
µg/l = micrograms per liter

For screening individual sample results from the site, the first step is to determine the sample concentrations that exceed the regional background value.

3.5.1 Soils Data

Based on a comparison with background metal concentrations in soil as established by WDOE, the site sample data set appears to suggest that contamination may exist from site activities. This has resulted in elevated soil concentrations for the following metals: arsenic, beryllium, cadmium, copper, and lead. Either 10 percent of the sample results for these metals are greater than background, or a single concentration value is more than twice the corresponding background value.

The comparison of WDOE-published background metals concentrations to site soil sample results may not be appropriate. Because natural or area background concentrations near the site may be greater than the WDOE-published background metal concentrations (Appendix C), a determination of site-specific background concentrations is warranted. Natural background is defined by WDOE as "the concentration of a hazardous substance consistently present in the environment which has not been influenced by human activity". The number of samples required to establish natural background concentrations is specified by WDOE as 10 or more soil samples.

Area background is defined by WDOE as "the concentrations of hazardous substances that are consistently present in the environment in the vicinity of a site which are the result of human activities unrelated to releases from that site." The number of samples required to establish area background are specified by WDOE as 20 or more soil samples.

For this site, determining natural background concentrations is necessary to further evaluate the elevated sample concentrations. The 95th upper confidence limit of the data set should be calculated after performing appropriate data set transformations as specified by WDOE (WDOE 92-54, 1992). The results, although not statistically significant, suggest that background concentrations of beryllium at the site may be greater than regional values.

If a comparison of the site sample data set with the natural background concentrations indicates contamination, then the source and extent of metals in soil must be determined.

The only metal that exceeds the Model Toxics Control Act (MTCA) cleanup levels for soil is beryllium. If cleanup action is required, then a MTCA Method B risk assessment that considers the reasonable maximum exposure from all elevated soil constituents should be performed to establish site-specific cleanup levels.

3.5.2 Groundwater Data

Trace metal concentrations in groundwater were determined for samples collected from two monitoring wells located downgradient of IRP Site 1 - Burial Site. Detected concentrations exceed WDOE cleanup levels for the following parameters: arsenic, beryllium, chromium and lead. These exceedences indicate that a further investigation of the source, nature, and extent of these parameters is necessary.

The presence of elevated concentrations of metals in groundwater may not be related to site activities. Sample preparation for the site sample data set did not include filtering. As a result, concentrations presented as dissolved phase metals may represent metals leached from sediments within the samples during sample preparation. An accurate determination of metal concentrations in groundwater requires the collection and subsequent analysis of filtered samples.

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SECTION 4.0

ENVIRONMENTAL SETTING

The environmental setting at Seattle ANGS is presented here to establish a reference for describing the proposed RI field work.

4.1 Topography

The Seattle ANGS is located in King County in the Puget Sound Lowlands physiographic province. The Puget Sound Lowlands is a north-south trending structural and topographic depression bordered on the west side by the Olympic Mountains and on the east by the Cascade Range. The Lowlands extend north from the Oregon-Washington State line to the Canadian border (OpTech, 1995).

The Seattle ANGS is located on flat terrain with a surface elevation of approximately 7 feet above mean sea level.

4.2 Meteorology

The climate in the Seattle area is characterized by mild summers and cool winters, with long spring and fall seasons. In winter, the daily temperatures range from 37° F to 47° F while in summer, the daily temperatures range from 55° F to 72° F. The average annual precipitation is 38.84 inches, including 7.4 inches of snow. The greatest percentage of rainfall occurs in the winter months from November to January. The average monthly precipitation ranges from 0.89 inches in July to 6.29 inches in December. The heaviest 24-hour rainfall of 3.74 inches was recorded on October 5-6, 1981. Rainfall intensity, based on a 2-year, 24-hour duration, is 2.0 inches. Free water surface evaporation in the Seattle area is approximately 25 inches per year, resulting in a net precipitation of 13.84 inches per year. The prevailing wind is from the southwest, and the highest average wind speed of 9.8 miles per hour is experienced during the month of March (OpTech, 1995).

4.3 Geology

The Seattle ANGS is situated in the central portion of the Puget Sound Lowlands, a broad glacial drift plain that is dissected by a network of deep marine embayments. The site is located within the north-south trending Duwamish Valley on the Duwamish Waterway flood plain, a former marine embayment that has been filled with sediment since the end of the last glaciation, referred to locally as the Vashon glaciation. The valley is bounded on the east and west by uplands of glacial drift and bedrock.

Sediments collectively termed as the Vashon drift represent the last major advance and retreat of glacial ice in the Puget Sound area, and commonly overlie a sequence of older glacial and nonglacial sediments throughout the site vicinity. Near the site, at least 75 feet of recent alluvium deposited by the Duwamish River is underlain by Vashon drift deposits.

Alluvial deposits in the Duwamish Valley primarily range from silt through silty sand to fine to medium sand. The alluvial deposits exhibit gradation common to meandering rivers which have resulted in intermittent layering of silts and sands with occasional layers of peat and organic materials deposited in marsh areas.

In the 1910s, much of the Duwamish Valley was raised with fill to accommodate development. The meandering Duwamish River was channelized in its present position during this time. Prior to extensive filling and regrading in the vicinity of Seattle ANGS between 1917 and 1919, a meander of the Duwamish River flowed along the eastern site boundary. Fill materials in the former channel bed in the vicinity of Seattle ANGS consist of up to 6 feet of silty sand to fine sand and over 1.5 to 10 feet of coal ash, clinkers, and brick fragments. Soils below the coal combustion residue consist of fine sand with a trace of gravel to a depth of at least 35 feet (OpTech, 1995).

Figures 4-1 and 4-2 present a geologic map of the Seattle, Washington area and a generalized stratigraphic column for the Puget Sound area, respectively.

4.4 Soils

The United States Department of Agriculture classified the soil underlying Seattle ANGS as unclassified urban land. Urban land is soil that has been modified by the disturbance of the natural layers with

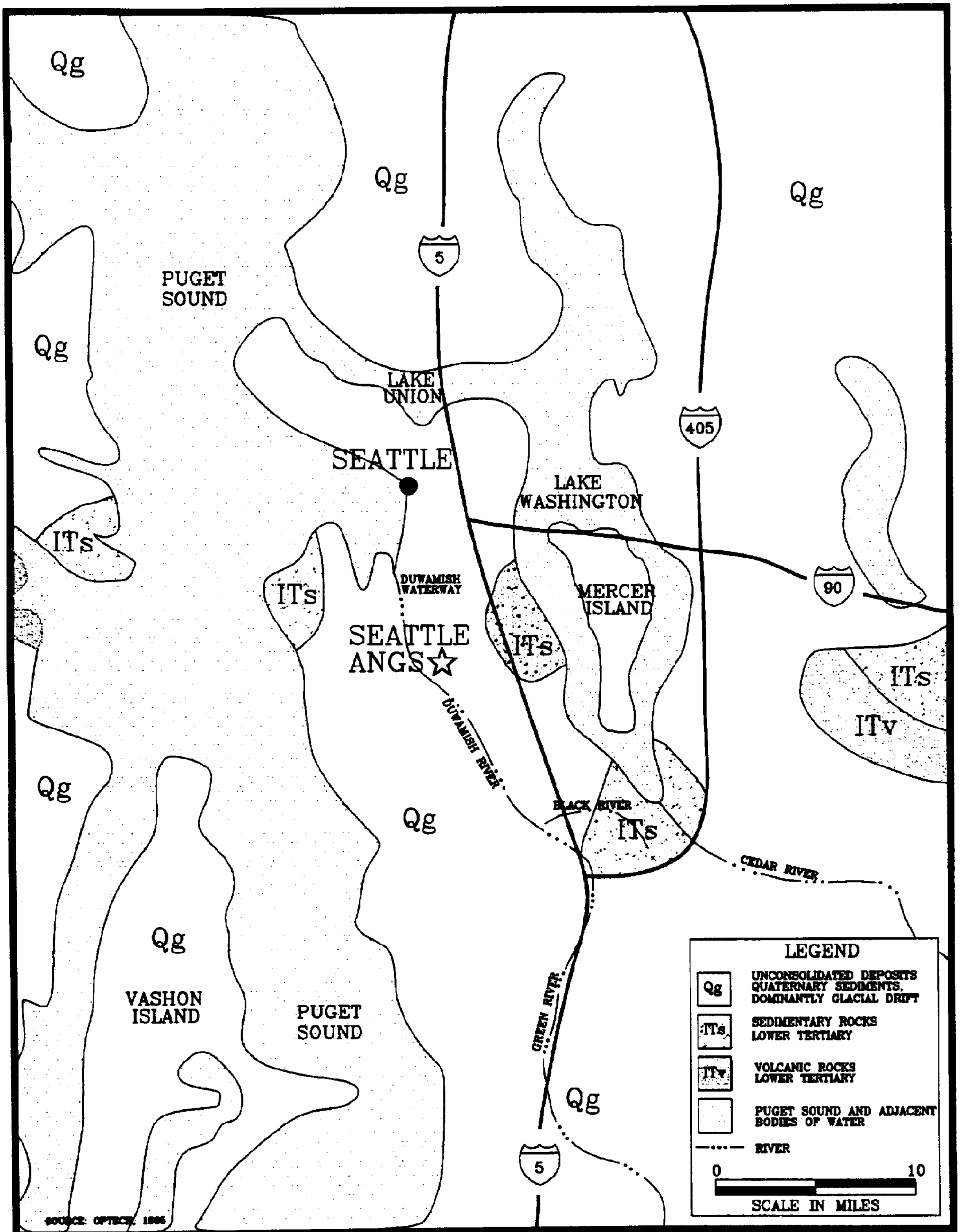

FIGURE 4-1

C:\CAD\DWGS\6016\SEA-SOIL

GEOLOGIC MAP OF THE
SEATTLE, WASHINGTON AREA
143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

EPOCH	PUGET LOWLAND: SOUTHERN	APPROXIMATE THICKNESS OF SOUTHERN UNITS (FEET)	PUGET LOWLAND: NORTHERN	AGE (YEARS)
HOLOCENE	RECENT ALLUVIUM	75		
PLEISTOCENE – LATE			FRASER DRIFT – SUMAS DRIFT	10,000
			FRASER DRIFT – EVERSON GLACIOMARINE DRIFT	11,000
	FRASHER DRIFT – VASHON DRIFT	NA	FRASER DRIFT – VASHON DRIFT – VASHON TILL	13,000
			FRASER DRIFT – VASHON DRIFT – ESPERANCE SAND	
			FRASER DRIFT – VASHON DRIFT – LAWTON CLAY	
	SEDIMENTS OF THE NONGLACIAL OLYMPIA INTERVAL	NA	SEDIMENTS OF THE NONGLACIAL OLYMPIA INTERVAL	20,000
			POSSESSION DRIFT	28,000 42,000
			WHIDBEY FORMATION (INTERGLACIAL)	90,000
			DOUBLE BLUFF DRIFT	100,000
	SALMON SPRINGS DRIFT – UPPER SALMON SPRINGS GRAVEL AND TILL	NA		250,000
	SALMON SPRINGS DRIFT – SILT, PEAT AND ASH	NA		
	SALMON SPRINGS DRIFT – LOWER SALMON SPRINGS GRAVEL AND TILL	NA		1,000,000
PLEISTOCENE – EARLY	PUYALLUP FORMATION (INTERGLACIAL)	130		
	STUCK DRIFT	NA		
	ALDERTON FORMATION (INTERGLACIAL)	25		
	ORTING DRIFT	200		2,000,000(?)

SOURCE: OPTECH, 1988

NA – NOT AVAILABLE

FIGURE 4-2

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GENERALIZED STRATIGRAPHIC COLUMN FOR THE PUGET SOUND LOWLANDS

143rd CCSQ, Seattle ANGS

Seattle, Washington

ERM

additions of fill material several feet thick to accommodate large industrial and housing installations. In the Duwamish River Valley, the fill ranges from about 3 to more than 12 feet thick, and from gravelly sandy loam to gravelly loam in texture. The erosion hazard is slight to moderate (OpTech, 1995).

Five Dutch cone penetrometer samples (hereinafter referred to as probes) and two borings were drilled by Hart Crowser and Associates, Inc., during soil studies conducted in 1974 and 1982 at Seattle ANGS. Sandy silt to silty sand was the most common sediment within the uppermost 10 feet of unconsolidated sediments. Sand, with occasional thin silty layers, is the predominant lithology from a depth of 10 to 50 feet bgs (OpTech, 1995).

4.5 Surface Water Hydrology

Seattle ANGS is located approximately one-quarter mile from the main channel of the Duwamish Waterway, a major surface water drainage basin for western Washington (Figure 1-1). Between 1917 and 1919, the meanders of the Duwamish River were filled in and the Duwamish Waterway was constructed. The western end of the meander near North Boeing Field was not filled and became the present day Slip No. 4.

The Federal Emergency Management Agency reported the drainage basin of the Duwamish as 450 square miles. The Waterway is composed of the Duwamish and the Green Rivers. Approximately 5.5 miles downstream of the station, the Duwamish discharges into Elliot Bay on the Puget Sound.

The Seattle Water Department indicated that the Duwamish Waterway is not used for drinking water and is the only fresh water downgradient of the station. Surface water drainage is totally controlled by man-made drainage systems that are routed into the municipal storm sewer. Figure 4-3 illustrates the storm drain systems at Seattle ANGS (OpTech, 1995).

4.6 Hydrogeology

The following subsections describe the regional and local hydrogeology in the vicinity of the Seattle ANGS.

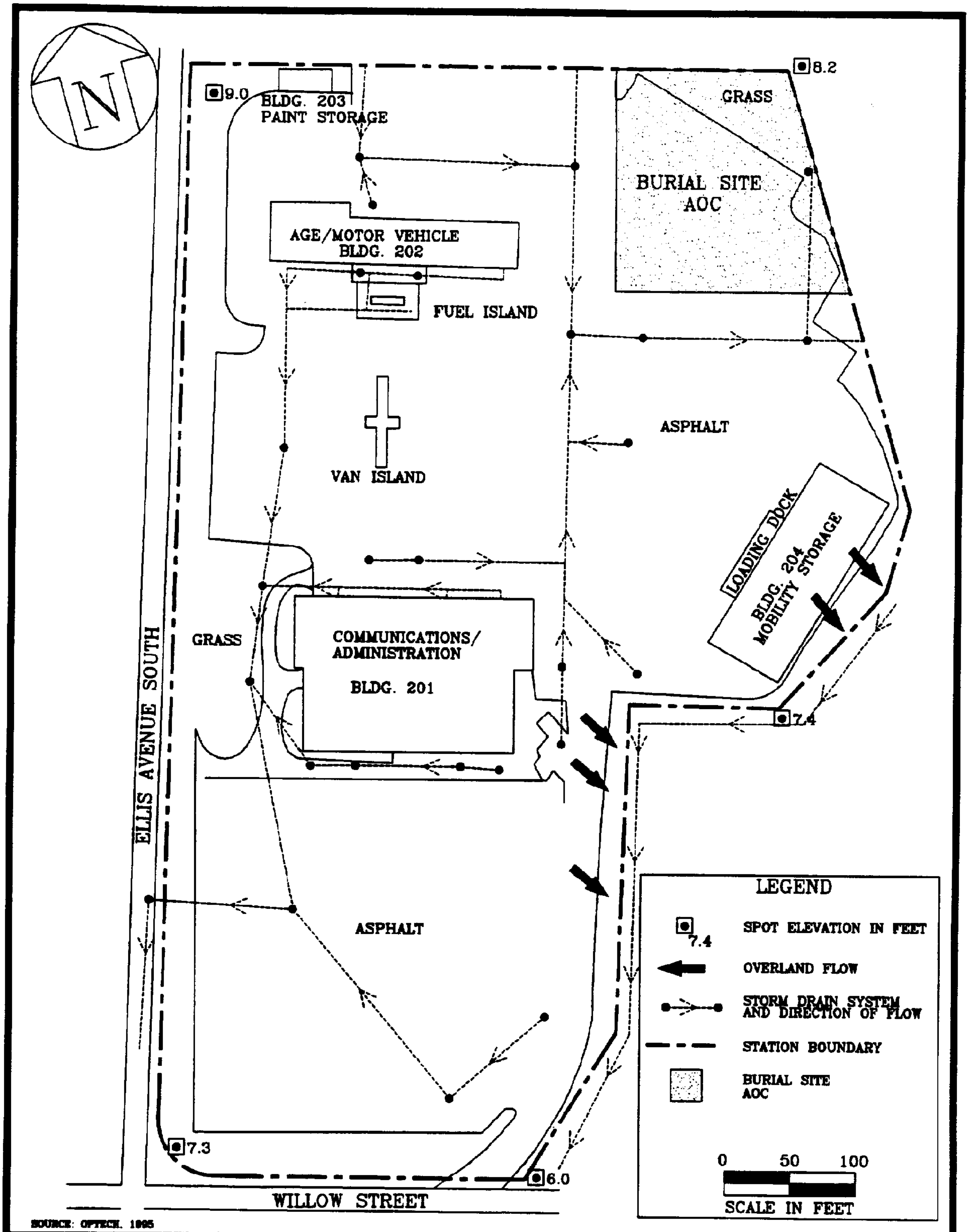

FIGURE 4-3

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SURFACE WATER DRAINAGE MAP
FOR THE BASE
143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

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4.6.1 Regional Hydrogeology

Groundwater is reported to exist in two lithostratigraphic units. A shallow groundwater unit is reported to exist within river alluvium. This unit is found underlying the Seattle ANGS and is described in the following section. Deeper groundwater is reported by Luzier (1963) beneath the river alluvium in the unconsolidated glacial deposits. Characteristics of the deeper groundwater aquifer are unknown; groundwater probably flows toward the Duwamish Waterway and thus to Elliot Bay within the deeper aquifer (OpTech, 1995).

OpTech (1995) reported that the Seattle Water Department has no municipal wells within 4 miles of the station, and records obtained from the WDOE's Water Resources Department indicated that no private drinking water wells are within a 1-mile radius of the Station. The surrounding population reportedly obtains drinking water from municipal water (OpTech, 1995).

The EDR environmental database report prepared as part of this work plan presents data regarding water supply wells in the United States Environmental Protection Agency's (EPA's) database and wells included in United States Geological Survey's database (Appendix B). All of the wells identified in the EDR report were located at greater than a one-mile radius from Seattle ANGS.

OpTech identified wells located within a 4-mile radius of the Seattle ANGS (OpTech, 1995). The wells were identified based on review of State records. Construction details, use, and ownership information for the wells identified during the OpTech record review are summarized in Table 4-1.

4.6.2 Local Hydrogeology

Groundwater under water table conditions occurs at shallow depths at Seattle ANGS within the upper part of the recent river alluvium. Investigations in the area have found that groundwater is influenced by seasonal precipitation and tidal fluctuations (OpTech, 1995).

Groundwater was encountered at a depth of approximately 5 feet bgs in January 1982 and 11 feet bgs in October 1974 during geotechnical investigations conducted by Hart Crowser and Associates, Inc. at Seattle ANGS. These measurements reflect water levels during the wet and dry seasons in the region, respectively. Several investigations undertaken by Seacor, Groundwater Technology, Inc., and Landau on behalf of Boeing at North Boeing Field have encountered groundwater at similar depths. Groundwater on the valley floor is generally

TABLE 4-1

Summary Data for Wells

143rd CCSQ, Seattle ANGS, Seattle, Washington

Section Number	Well Location*	Well Type	Owner	Date Completed	Total Depth (feet)	Perforated Interval (feet)	Static Water Level (feet below land surface)
Township 23 North and Range 4 East							
Section 1	--/SW/SW	Irrigation	City of Tukwila	Feb-88	134	37-57	15
Section 3	--/NW/NW	Dewatering	Boeing	Mar-93	23	20-23	--
	--/NW/NW	Dewatering	Boeing	Feb-93	23	20-23	--
Section 4	--/SW/SE	Dewatering	VL Seitz Construction	Dec-88	34	10-30	4
Section 7	--/NW/SW	Dewatering	Boeing	Apr-93 (Abandoned May-93)	38	16 -36	1.5
Section 9	-- / -- / --	Dewatering (3 wells)	Hos Bros	Apr-88	32	10-30	12
	-- / NW / NW	Irrigation	Ron Zimmerman	Jun-91	50	22-45	5
Section 10	-- / -- / NW	Dewatering (3 wells)	Boeing	Jul-93 (Abandoned Aug-93)	30	10-30	6
Section 11	-- / SE/ SE	Domestic	Jane Deasy	May-94	18	--	8
	-- / NW/NE	Dewatering	Panetta Bros Construction	Feb-90	30	--	8
	-- / SW/NE	Dewatering (163 well points)	Aldarra Corporate Park	Jul-93	23	20-23	8
	-- / SW/NE	Dewatering	Aldarra Corporate Park	Mar-93	23	20-23	3
Township 24 North and Range 3 East							
Section 13	--/SW/NW	Industrial	Salmon Bay Steel	Mar-93	511	450-500	5

TABLE 4-1

Summary Data for Wells
143rd CCSQ, Seattle ANGS, Seattle, Washington

Section Number	Well Location*	Well Type	Owner	Date Completed	Total Depth (feet)	Perforated Interval (feet)	Static Water Level (feet below land surface)
Township 24 North and Range 4 East							
Section 5	NW/SW/NW	Dewatering	Metro	Feb-86 (Abandoned Nov-90)	70	50-70	--
	--/NE/SW	Test Well	Texaco	Jun-92	25	10-25	--
	--/NE/SW	Test Well	Texaco	Jun-92	20	5-20	--
Section 8	--/--/SE	Cathodic Protection	Seattle Water Department	May-83	300	NA	--
Section 16	--/--/NW	Cathodic Protection	Seattle Water Department	May-83	304	NA	--
Section 17	--/NW/SW	Test Well	City of Seattle, Seattle City Light	Dec-86	20.5	14 - 19.5	12
	--/NW/SW	Test Well	City of Seattle, Seattle City Light	Dec-86	25.5	18 - 23.5	12
	--/NW/SW	Test Well	City of Seattle, Seattle City Light	Dec-86	25	14.5 - 20	12.5
	--/NW/SW	Test Well	City of Seattle, Seattle City Light	Dec-86	24.5	8.5 - 14	11.5
	--/NW/SW	Dewatering	Scotty's General Construction	Sep-91	36	10 - 30	8

NA = not applicable
* = Location indicated as follows: 10 acre division/40 acre division/160 acre division (or quarter, quarter, quarter of indicated section).
-- = Indicate location information not available on drilling logs

encountered at depths between 4 and 11 feet bgs. Groundwater flow in the vicinity of Seattle ANGS is generally to the west/southwest, toward the Duwamish Waterway, at a gradient of approximately 0.002 foot per foot. Data compiled from monitoring wells developed as a result of investigations at North Boeing Field show that groundwater flow directions near Seattle ANGS are generally to the west, southwest, or south (OpTech, 1995).

Groundwater is reportedly in the unconsolidated sediments beneath the recent alluvium (Luzier, 1969). Characteristics of the deeper groundwater aquifer are unknown, though groundwater likely flows toward the Duwamish Waterway and Elliot Bay (OpTech, 1995).

SECTION 5.0

PERMITS

Monitoring well installation at the site will require submission of a Notice of Intent to Construct a Monitoring/Resource Protection Well to the Washington State DOE at least 3 days prior to commencing work at the site. This permit is typically applied for by the drilling company completing the monitoring wells at the site. No other permits or notices are required for the investigation methods proposed in this work plan for project work within the boundaries of the Seattle ANGS.

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SECTION 6.0

INVESTIGATIVE APPROACH

6.1 Work Plan Objectives

The RI will be conducted at Seattle ANGS to determine the nature and extent of contamination at IRP Site 1 - Burial Site. Both soil and groundwater investigations will take place at the site. The objectives of the RI are as follows:

- Define the geologic and hydrogeologic setting at Seattle ANGS.
- Determine background conditions for trace metals and radionuclides, petroleum hydrocarbons in groundwater and soil.
- Define the extent of groundwater contamination downgradient of IRP Site 1 - Burial Site.

6.2 General Approach

The following sections summarize the purpose and general approach to be used during the RI field investigation.

6.2.1 Geoprobe™/Hydropunch™

Geoprobe™/Hydropunch™ groundwater samples will be collected during RI field activities. The purpose of sample collection is three-fold:

- Provide a more wide-spread distribution of groundwater sampling points at locations downgradient of IRP Site 1 - Burial Site; and
- Provide additional groundwater data in order to assess the potential for on-Station transport of volatile organic compounds (VOCs) and TPH from upgradient sources.
- Provide additional data regarding subsurface lithology.

6.2.2 Surface Soil Sampling

Surface soil samples will be collected during RI field activities. Surface soil is defined as the soil extending from the surface to a depth of no more than 1 foot bgs. The purpose of surface soil sampling is to assess the potential on-Station transport of TPH and radionuclides from off-site locations. The samples will also be analyzed for VOCs if field screening indicates that TPH concentrations exceed MTCA standards or if visual staining is present.

6.2.3 Storm Sewer Sediment Sampling

Storm sewer catch basin sediment samples will be collected during RI field activities. The samples are for the purpose of assessing the potential of sediments eroded from IRP Site 1- Burial Site to be transported off-Station via the existing storm sewer system.

6.2.4 Subsurface Soil Sampling

Soil borings will be drilled and sampled during RI field activities to collect subsurface soil samples for chemical analysis. The soil borings are for the purpose of defining the vertical and lateral extent of soil contamination at IRP Site 1 - Burial Site and for the purpose of further defining background soil quality conditions underlying Seattle ANGS.

6.2.5 Monitoring Well Installation

Monitoring wells will be installed during RI field activities at Seattle ANGS. Monitoring wells are for the purpose of defining the lateral extent of groundwater contamination downgradient of IRP Site 1 - Burial Site and for the purpose of further defining background groundwater quality conditions underlying Seattle ANGS.

The target total depth for all monitoring wells is 20.5 feet bgs. The monitoring wells will be constructed in a similar manner to monitoring wells installed during the SI to allow comparable groundwater quality data to be collected.

ERM may recommend installing additional monitoring wells at Seattle ANGS if the results of the Geoprobe™/Hydropunch™ task suggests that the extent of groundwater contamination downgradient from IRP Site 1 - Burial Site may not be adequately defined based on the planned monitoring well locations.

6.2.6 Slug Testing

Slug testing will be performed at one RI monitoring well to estimate hydraulic conductivity for the shallow aquifer underlying Seattle ANGS. The hydraulic conductivity estimate will be used along with groundwater flow gradient data and estimated aquifer porosity to help estimate groundwater flow velocity. An optional aquifer test may also be performed.

6.2.7 Groundwater Monitoring

Groundwater quality and levels will be monitored on a quarterly basis for 1 year. The purpose of the 1-year monitoring period is to collect sufficient groundwater quality and level data to represent groundwater conditions over an annual seasonal cycle.

Static groundwater level monitoring will also be performed at Seattle ANGS. Groundwater levels will be measured in all existing monitoring wells at the Station prior to the start of sampling activities during the particular monitoring round. Groundwater levels will be contoured and used to estimate groundwater flow direction and gradient.

6.2.8 Analytical Methods

Samples collected during RI field activities will be analyzed using procedures that conform to EPA guidelines published in *Test Methods for Evaluating Solid Wastes (SW-846), Third Edition* and that conformed to guidelines issued by the WDOE.

6.3 Site Investigation Activities at IRP Site 1 - Burial Site

The following subsections summarize the site investigation activities to be performed during the Seattle ANGS RI. Table 6-1 provides a site investigation summary.

6.3.1 Geoprobe™/Hydropunch™

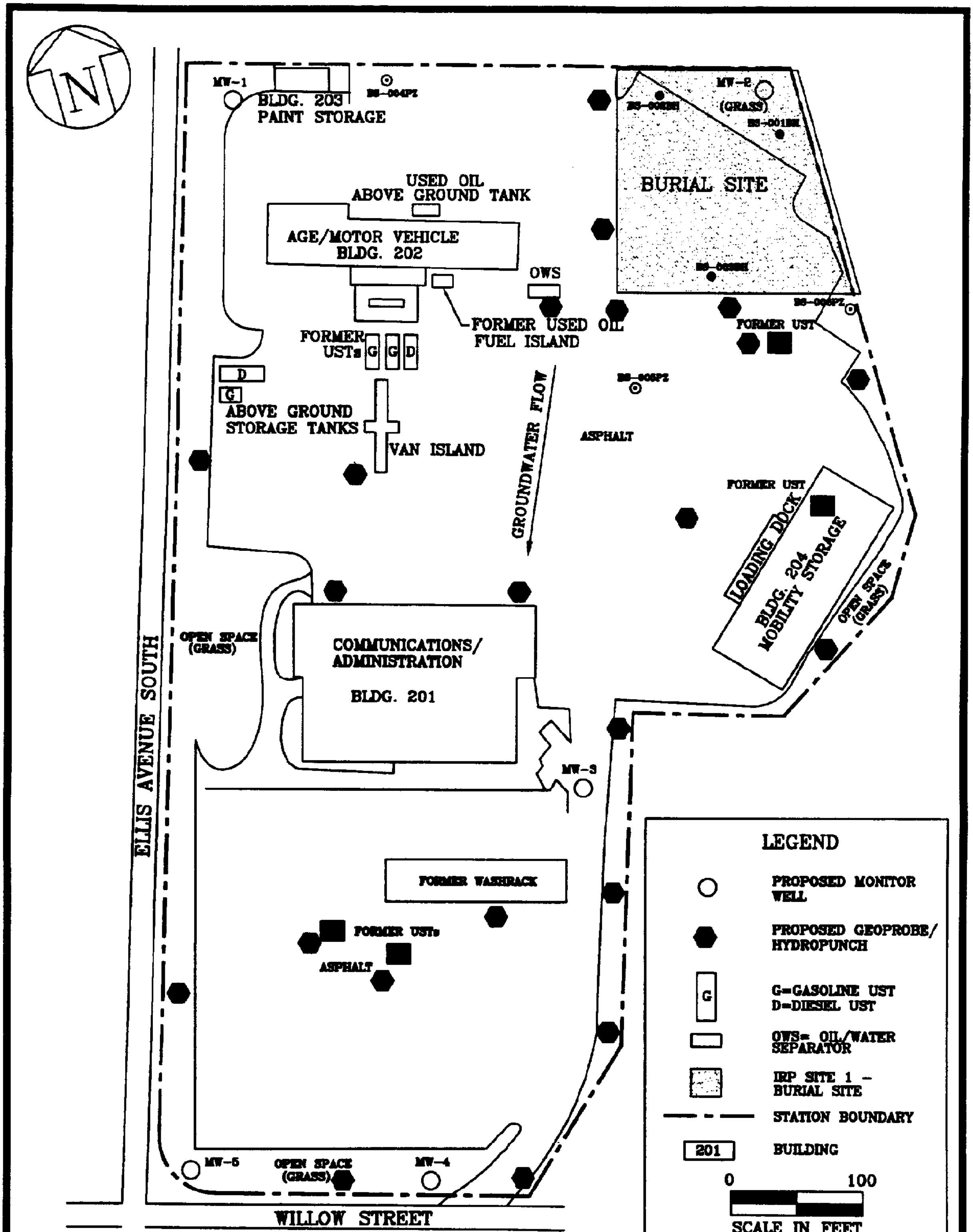
Twenty-two Geoprobe™/Hydropunch™ groundwater samples will be collected during RI field activities (Figure 6-1). Samples collected during the Geoprobe™/Hydropunch™ sampling activity will be analyzed in the field using a mobile laboratory. Samples will be

TABLE 6-1

Remedial Investigation Field Program
143rd CCSQ, Seattle ANGS, Seattle, Washington

Activity	Number and Type of Sample Locations	Number of Original Samples
Subsurface Soil Sampling	3 Background Borings 8 Characterization Borings	9 16
Surface Soil Sampling	10 Sample Locations	10
Storm Sewer Sediment Sampling	2 Locations	2
Monitoring Well Installation	1 Background Monitoring Well 4 Characterization Monitoring Wells	* *
Groundwater Sampling	22 Hydropunch Sampling Locations	22
Groundwater Monitoring Program	5 Remedial Investigation Monitoring Wells 2 Site Investigation Monitoring Wells	20 8
Aquifer Parameter Determination	1 Slug Test	Not Applicable

* = Refer to groundwater monitoring program



SOURCE: OPTECH, 1995

FIGURE 6-1

PROPOSED MONITORING WELLS AND GEOPROBE/HYDROPUNCH SAMPLING LOCATIONS
143rd CCSQ, Seattle ANGS
Seattle, Washington

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collected from the each probe location for the purpose of lithologic logging. The lithologic data will be used, along with data collected during drilling of soil borings and monitoring wells, for construction of geologic cross sections.

6.3.2 Surface Soil Sampling

Ten surface soil samples (SS-1 through SS-10) will be collected during RI field activities. Surface soil is defined as the soil extending from the surface to a depth of no more than 1 foot bgs. The primary purpose of the surface soil samples is to assess the potential on-Station transport of TPH and radionuclides from off-site locations (Figure 6-2). The secondary purpose is to evaluate the potential for on-site transport of SVOCs and VOCs.

6.3.3 Storm Sewer Sediment Sampling

Two storm sewer catch basin sediment samples (SW-1 and SW-2) will be collected during RI field activities. The samples are for the purpose of assessing the potential of sediments eroded from IRP Site 1- Burial site to be transported off-Station via the existing storm sewer system.

6.3.4 Subsurface Soil Sampling

A total of 11 soil borings (SB-1 through SB-11) will be drilled for collection of subsurface soil samples. Borings SB-1 through SB-3 will be drilled in background locations to collect soil samples to evaluate background concentrations of trace metals. Borings SB-4 through SB-11 will be drilled at IRP Site 1 - Burial Site for characterization of subsurface soil chemical quality. Four of the 8 site characterization borings will be placed on the perimeter of the area identified during the SI geophysical investigation as a "disturbed soil" area.

6.3.5 Monitoring Well Installation

Five monitoring wells will be installed during RI field activities at Seattle ANGS. Four monitoring wells (MW-2 through MW-5) are for the purpose of defining the lateral extent of groundwater contamination downgradient of IRP Site 1 - Burial Site. One monitoring well (MW-1) is for the purpose of further defining background groundwater quality conditions underlying the Station (Figure 6-1).

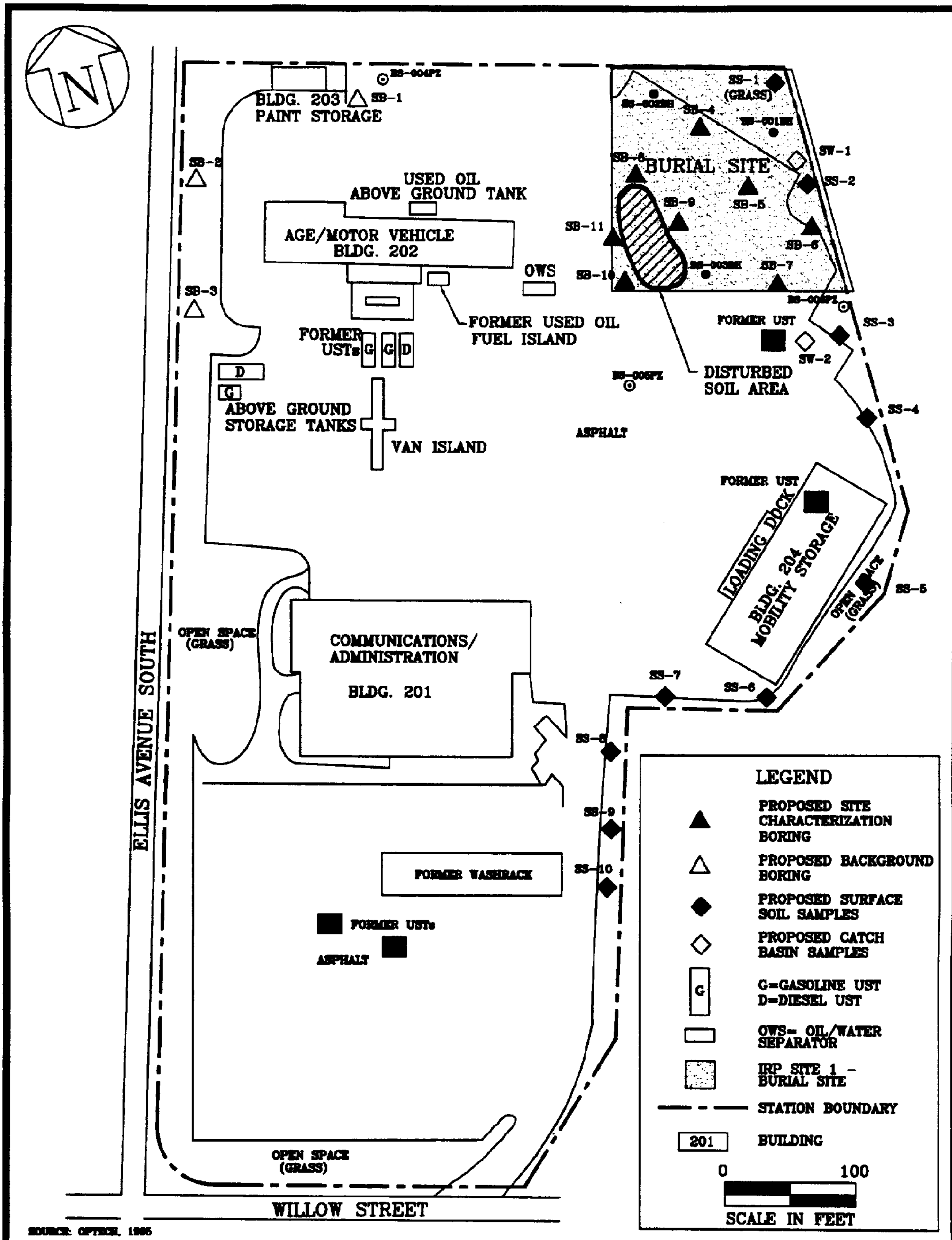

FIGURE 6-2

PROPOSED SOIL BORING, SURFACE AND CATCHMENT BASIN SAMPLES
143rd CCSQ, Seattle ANGS
Seattle, Washington

ERM

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6.3.6 Slug Testing

One short-term slug test will be performed at downgradient monitoring well MW-3 to estimate hydraulic conductivity for the shallow aquifer underlying Seattle ANGS (Figure 6-1).

6.3.7 Groundwater Monitoring

Existing monitoring wells installed during the SI (BS-004PZ through BS-006PZ) will be sampled during four quarterly rounds. The first round will be collected far enough in advance of the start of RI field work so that laboratory analyses can be completed and reviewed by ERM and ANG/CEVR prior to mobilization of the driller to the Station. The three remaining quarterly rounds will be conducted concurrently with sampling of monitoring wells installed during the RI.

Monitoring wells MW-1 through MW-5 will be sampled during five occasions: immediately after development is completed; approximately 4 weeks after well completion; and during the remaining three quarterly monitoring events.

6.3.8 Analytical Methods

Analytical methods to be used during sample analysis are summarized in Table 6-2. Further information regarding quantitation levels and QA/QC for laboratory analyses are included in Appendix D.

6.4 Deviations from the Work Plan

Any significant deviations from the activities, procedures, or analyses performed pursuant to this work plan will be discussed and approved in advance with the ANG/CEVR Project Manager. A description of all such deviations will be included in the RI Report.

TABLE 6-2
Laboratory Analysis Summary
143rd CCSQ, Seattle ANGS, Seattle, Washington

Site	Matrix	Sampling Method	Field Parameters	Lab Parameters	EPA Method	Original Samples	QA/QC Samples					Matrix Total*
							Trip Blank	Rinsate Blank	Field Blank	Field Duplicate	MS/MSD	
Background	Subsurface Soil 3 Sites	Soil Borings	Soil headspace screening using PID/field TPH	PP Metals	3050/6010/6020/7470	9		1		1		10
			Soil classification	SVOCs	3550/8270	9		1		1		10
				TPH	WTPH-HCID	9		1		1		10
				Radionuclides	SM-7110A/B, 903.1, 904.0	9		1		1		10
	Groundwater 1 RI MW 1 SI MW	Monitoring Wells (per round)	Temperature	PP Metals	6010/6020/7470	2						2
			pH	VOCs	5030/8260	2	1					2
			Specific conductance Turbidity	SVOCs	3550/8270	2						2
				TPH	WTPH-HCID	2						2
				Radionuclides	SM-7110A/B, 903.1, 904.0	2						2
IRP Site No.1	Subsurface Soil 8 Sites	Soil Borings	Soil headspace screening using PID/field TPH	PP Metals	3050/6010/6020/7470	16		1	1	1	2	19
			Soil classification	TPH	WTPH-HCID	16		1	1	1	2	19
				SVOCs	3550/8270	16		1	1	1	2	19
				Radionuclides	SM-7110A/B, 903.1, 904.0	16		1	1	1	2	19
	Storm Sewer Catch Basin 2 Sites	Grab Samples	Soil headspace screening using PID/field TPH	PP Metals	3050/6010/6020/7470	2						2
				TPH	WTPH-HCID	2						2
				SVOCs	3550/8270	2						2
				VOCs	5030/8260	2						2
				Radionuclides	SM-7110A/B, 903.1, 904.0	2						2

TABLE 6-2

Laboratory Analysis Summary
143rd CCSQ, Seattle ANGS, Seattle, Washington

Site	Matrix	Sampling Method	Field Parameters	Lab Parameters	EPA Method	Original Samples	QA/QC Samples					Matrix Total*
							Trip Blank	Rinsate Blank	Field Blank	Field Duplicate	MS/MSD	
IRP Site No. 1 (cont.)	Surface Soil 10 Sites	Surface Sampling	Soil headspace screening using PID/field TPH	TPH	WTPH-HCID	10			1	1	1	12
				VOCs and SVOCs	8260 and 8270	To be selected based on field screening						
			Soil classification	Radionuclides	SM-7110A/B, 903.1, 904.0	10			1	1	1	12
	Groundwater 4 RI MW 2 SI MW	Hydropunch (field lab)	Temperature, pH Specific conductance	Selected VOCs	8010/8020	22				2	1	25
				TPH	WTPH-HCID	22				2	1	25
		Monitoring Wells (per round)	Temperature	PP Metals	6010/6020/7470	6		1	1	1	1	8
			pH	VOCs	5030/8260	6	1	1	1	1	1	8
			Specific conductance Turbidity	SVOCs	3550/8270	6		1	1	1	1	8
				TPH	WTPH-HCID	6		1	1	1	1	8
				Radionuclides	SM-7110A/B, 903.1, 904.0	6		1	1	1	1	8

VOCs = volatile organic compounds
SVOCs = Semi-volatile organic compounds
PP Metals = Priority Pollutant trace metals
TPH = total petroleum hydrocarbons
QA/QC = quality assurance/quality control
MS/MSD = matrix spike/matrix spike duplicate
WTPH-HCID = State of Washington TPH analysis - hydrocarbon identification method
EPA = Environmental Protection Agency
PID = photoionization detector
RI = Remedial Investigation
SI = Site Inspection
MW = Monitoring Well
* = Blank samples not included in matrix total
GC = gas chromatograph

SECTION 7.0

FIELD INVESTIGATION PROCEDURES

7.1 Investigation Methods and Procedures

The following subsections summarize the field investigation methods and procedures and field screening techniques to be used during RI field work at the Seattle ANGS.

7.1.1 Geoprobe™/Hydropunch™

Samples collected during the Geoprobe™/Hydropunch™ sampling activity will be analyzed in the field using a mobile laboratory. It is anticipated that the field work for this activity can be completed within a 2-day period. Additional Geoprobe™/Hydropunch™ groundwater samples may be collected during this period if sufficient time exists for the field laboratory to perform the required analyses.

Groundwater samples collected by Geoprobe™/Hydropunch™ methods will be analyzed in the field by a State-approved analytical mobile laboratory for VOCs, benzene, toluene, ethylbenzene, and xylene (BTEX), TCE, and TPH. EPA Methods to be used during the analysis of Hydropunch™ groundwater samples are presented in Section 6.0.

7.1.2 Surface Soil Sampling

Surface soil samples will be collected during RI field activities. Surface soil is defined as the soil extending from the surface to a depth of no more than 1 foot bgs. Surface soil samples will be collected using hand auger equipment. At sample locations where soil is exposed at the surface, the samples will be collected from land surface to a depth of 6 inches. At sample locations that are paved, the soil sample will be collected a minimum of 6 inches below the top of the native soil surface underlying the asphalt or concrete paving.

Surface soils will be field screened using field test kits for TPH analysis (Section 7.2.2). All surface soil samples will be submitted to a State-certified analytical laboratory for confirmatory analysis of TPH and radionuclides (gross alpha, gross beta, radium-226, and radium-228). If field screening indicates that TPH concentrations exceed MTCA standards or if visual staining is present, the samples will also be analyzed for VOCs and SVOCs. EPA Methods to be used during the confirmatory analysis are presented in Section 6.0.

For soil sample analysis, there are four TPH methods used in the State of Washington. In situations where it is not known what type(s) of hydrocarbons are present, the recommended method is WTPH-HCID. This method includes a scan of gasoline-range, diesel-range, and heavy-end hydrocarbons. For each range, there are established thresholds above which further analysis is required. Specifically, if the data indicate that gasoline-range hydrocarbons are present at a concentration exceeding 20 milligrams per kilogram (mg/kg), then the sample must also be analyzed for gasoline and BTEX by WTPH-G/8020. If the data indicate that diesel-range hydrocarbons are present at a concentration exceeding 50 mg/kg, then the sample would be also be analyzed for diesel by WTPH-D. Lastly, if the data indicate that heavy-end hydrocarbons are present at a concentration exceeding 100 mg/kg, then the sample would be analyzed for heavy-end hydrocarbons by WTPH-D extended.

7.1.3 Storm Sewer Sediment Sampling

Grab samples will be collected from the two catch basins using a trowel or scoop. Storm sewer catch basin samples will be submitted to a State-certified analytical laboratory for analysis of Priority Pollutant (PP) trace metals (i.e., arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), copper, beryllium, TPH, VOCs, SVOCs, and radionuclides (gross alpha, gross beta, radium-226, and radium-228). EPA Methods to be used during the analysis of catch basin sediment samples are presented in Section 6.0.

7.1.4 Drilling Procedures

The following subsections describe the activities involved in borehole and monitoring well drilling. The objectives of the drilling program are: (1) to obtain soil samples for chemical analysis, (2) to define the lateral and vertical extent of soil contamination at the investigated site, and (3) to install groundwater monitoring wells. Monitoring wells will be used to identify the presence and extent of groundwater contamination and to obtain water level data for hydrogeologic characterization of the aquifer.

7.1.4.1 Drilling Procedures

Prior to the start of drilling activities, a general review of all utilities including underground and waste water lines in the vicinity of the drilling site will be made and digging permits will be completed and submitted to the appropriate station personnel for approval. Any fees, permits, or licenses required for any drilling activities will be paid by ERM's subcontractor prior to the commencement of drilling. In the event that any of the planned drilling locations are found to interfere with buried water or wastewater lines, or are located in an area subject to frequent flooding, the soil boring will be relocated as closely as possible to the original location. Relocated drilling locations will be approved by ERM's Project/Site Manager and the Seattle ANGS Civil Engineer or designated representative. Planned drilling locations will be staked in the field for inspection and approved by Station personnel of the Civil Engineering Office. Once all activities have been completed at each specific drilling point, the location will be staked to facilitate subsequent surveying.

Soil borings and monitoring wells will be drilled using hollow stem auger methods. Figure 7-1 shows the proposed design for monitoring wells to be installed during RI activities. The number, locations, and purpose of proposed soil borings and monitoring wells at IRP Site 1 - Burial Site are discussed in Section 6.0.

7.1.4.2 Borehole Logging

An experienced geologist will be present at the auger drilling rig at the Geoprobe™ rig for logging samples, monitoring drilling operations, recording soil and groundwater data, monitoring and recording the well installation procedures of the rig, and preparing boring logs and well diagrams. The geologist will have sufficient tools and professional equipment in operable condition to efficiently perform these duties.

The field geologist and all on-site personnel will maintain field notebooks during field activities. Each field notebook will be a weather-resistant, bound, survey-type field book with nonremovable pages and will be assigned a unique number. All data generated during the investigation and any comments or other notes will be entered directly into the field notebook. At the end of the project and upon request, ANG/CEVR will be provided a copy of all field notebooks.

The lithologic record recorded by the geologist during the drilling of each borehole, monitoring well, and Geoprobe™ point will be based on

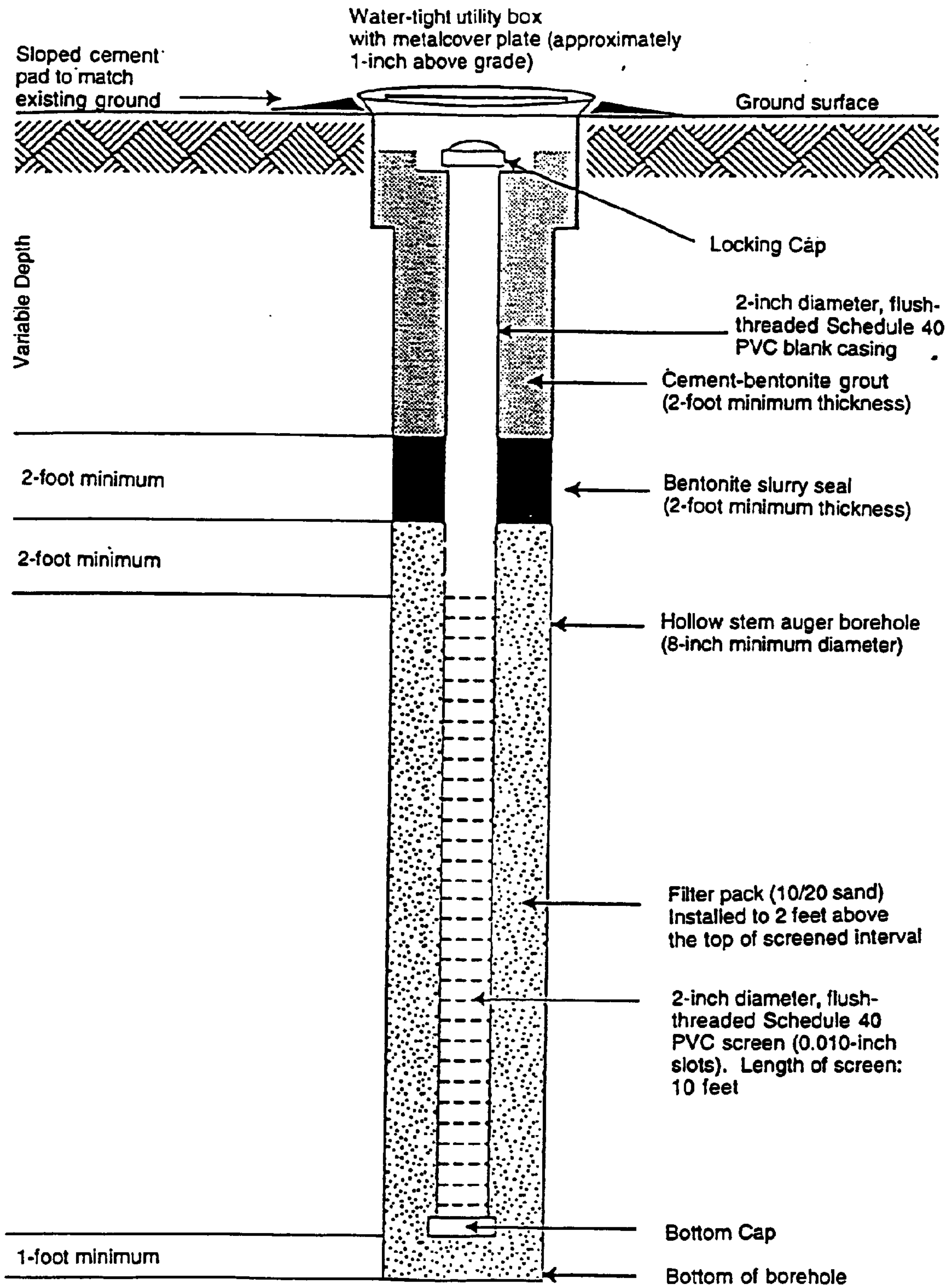

FIGURE 7-1

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PROPOSED MONITORING WELL DESIGN

143rd CCSQ, Seattle ANGS
Seattle, Washington

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the visual inspection of the soil samples supplemented by examining the drill cuttings. Material will be classified using the Unified Soil Classification System and described according to American Society for Testing and Materials (ASTM) D2488-69, "Description of Soils (Visual Manual Procedure)". The lithologic data collected during drilling and Geoprobe™ point installation will be used to construct geologic cross-sections.

The following information will be logged for each boring:

- Boring identification number;
- Name of driller and geologist;
- Method of drilling;
- Auger flight size;
- Sampling method and depth;
- Standard penetration test blows;
- Photoionization detector (PID) readings;
- Hole location and elevation;
- Reference elevation for all depth measurements;
- Detailed soil descriptions using the Unified Soil Classification System, including soil moisture/saturation condition;
- Depth at which each distinct stratum is encountered;
- Depth at which groundwater is first encountered while drilling;
- Depth of completed soil boring or monitoring well;
- Weather and temperature; and
- Signatures of those performing the work.

7.1.5 Subsurface Soil Sampling

Soil borings will be drilled and sampled during RI field activities to collect subsurface soil samples for chemical analysis. Subsurface soil samples will be collected from each soil boring using a split-spoon drive sampler.

Soil borings will be terminated at the top of the water table at the investigation site where unconfined or water table conditions occur. All soil samples will be collected in the unsaturated zone. A target total drilling depth will be determined prior to the start of drilling activities at each soil boring. The thickness of the unsaturated zone at each sample site will be determined by the on-site geologist based on geologic conditions and water level measurements taken in nearby SI monitoring wells. During SI field activities in July 1994, groundwater was encountered at approximately 10 feet bgs in all borings and monitoring wells drilled at Seattle ANGS.

Continuous drive samples will be collected using the split-spoon sampler from the interval between land surface to the target total depth. One subsurface soil samples from each split spoon drive interval will be analyzed for TPH utilizing field screening kits and for presence of organic vapors using a PID. Three subsurface soil samples collected at the background borings and two subsurface borings at IRP Site 1 - Burial Site will be designated for analyses and submitted to a State-certified analytical laboratory for analysis of TPH, SVOCs, PP trace metals, beryllium, copper, and radionuclides (gross alpha, gross beta, radium-226, and radium-228). One optional sample from each boring at IRP Site 1 - Burial Site will also be submitted to the laboratory. This sample will be designated for TPH, SVOC, and VOC analysis only if field screening indicates the presence of contamination. The sample will then be held in the laboratory and analyzed for trace metals only if the upper or lower samples contain significant concentrations of trace metals. EPA Methods to be used during the laboratory analysis of subsurface soil samples are presented in Section 6.0. Section 7.1.2 also provides additional information regarding the decision process used during laboratory analysis of TPH in soil samples.

7.1.6 Monitoring Well Installation

Monitoring wells installed during the RI field activities at Seattle ANGS are for the purpose of defining the lateral extent of groundwater contamination at the investigated site. Monitoring well locations were selected to supplement groundwater quality information available from existing monitoring wells installed during the SI and based on historic groundwater flow directions in the vicinity of each investigation site. Groundwater flow directions will be measured prior to the start of drilling activities to supplement existing historic data.

The target total depth for all monitoring wells is 20.5 feet bgs. The monitoring wells will be constructed in a similar manner to monitoring wells installed during the SI to allow comparable groundwater quality data to be collected.

ERM may recommend installing additional monitoring wells at Seattle ANGS if the results of the Geoprobe™/Hydropunch™ task suggests that the extent of groundwater contamination downgradient from IRP Site 1 - Burial Site may not be adequately defined based on the planned monitoring well locations.

7.1.6.1 Monitoring Well Construction

Monitoring wells will be installed by a State of Washington qualified well driller using the hollow-stem auger method to a total depth of 20.5 feet bgs. Soil samples will be collected at 5-foot intervals for geologic classification and field screening using a PID and TPH field test kit. Monitoring wells will be constructed in accordance with applicable State of Washington well standards and in a similar manner to monitoring wells installed during the SI in order to allow comparable groundwater quality data to be collected. The well construction materials will be decontaminated before being installed in the borehole. The proposed design for the monitoring well installation during the RI activities is shown on Figure 7-1.

The monitoring wells will be constructed of threaded, flush-joint, 2-inch Schedule 40 PVC casing and screen. Well casing will be provided with a cap of similar diameter. No solvents, cements, or adhesive tapes will be used to connect sections of the well casing. The well screen will consist of threaded, flush-joint pipe with 0.010 inch slot size. No solvents, cements, or adhesive tapes may be used to connect sections of the screen.

Each monitoring well will be screened from the top of the piezometric surface to total depth, with allowance for seasonal fluctuations. In areas where floating product is suspected, the screened interval will be adjusted to allow for the collection of floating product, if desired.

The annular space between the well screen and the borehole wall will be backfilled with clean, washed, well-graded, 10/20 silica sand installed to 2 feet above the screened interval. A bentonite slurry seal will be placed above the sand pack. The remaining annular space will be grouted using a cement-bentonite grout mixture. A performance test will be conducted after well completion to ensure that the monitoring well is straight and has not collapsed.

A minimum 8-inch-ID, protective steel casing with a hinged or removable lockable steel cap shall be installed over the monitoring well casing that projects above ground surface. Concrete used for completion at grade will be Sakrete, Quikrete, or equivalent, and will not be placed around the monitoring well prior to 24 hours after setting the protective steel casing in the cement/bentonite grout. If necessary, three 2-inch-diameter steel posts may be installed to provide extra well head protection. If a monitoring well is required to be completed below grade due to traffic or other considerations, a protective steel casing with hinged and lockable steel cap will be used beneath a manhole cover. Alternatively, a locking traffic-grade cover may be used.

7.1.6.2 Monitoring Well Development

Monitoring well development will proceed within 24 to 48 hours after well completion. The monitoring well will be developed using either a submersible pump or bailer. Monitoring well development will consist of repeated evacuation and surging until the clarity of the water has stabilized. A turbidity meter will be used to help determine when stabilization of clarity has occurred.

The water levels in each monitoring well will be measured before development begins. An electric water level indicator accurate to 0.01 foot will be used to measure the depth to water from a prescribed point on the well casing.

Temperature, conductivity, and pH will be monitored and recorded during well development. A minimum of 10 well volumes will be purged and at least three times the volume of any potable water added during drilling will be removed.

Physical and chemical parameters including temperature, pH, turbidity and specific conductance of the water will be measured during well development. Well development will continue until the temperature, specific conductance, turbidity and pH have stabilized and the groundwater removed is clear and free from sand. A record as to how much water was removed during the development of the monitoring well will be maintained.

The following information will be recorded in a field log during development of each monitoring well:

- Date;

- Well number and location;
- Reference evaluations for all depth measurements;
- Depth at which groundwater is first encountered while drilling and 24 hours after completion;
- Depth of monitoring well;
- Depth and type of monitoring well casing;
- Static water level upon completion of the monitoring well and after development;
- Depth to water table before development begins;
- Depth to top of the screen;
- Pertinent construction details, such as description of gravel pack material;
- Purge method and rate;
- Documentation of pH and specific conductance meter calibration;
- Temperature, pH, and specific conductance measure for the initial groundwater sample and subsequent sampling; and
- Signatures of those performing the work.

7.1.7 Slug Testing

ERM will perform a slug test at RI monitoring well MW-3 to allow for estimation of aquifer parameters in the shallow aquifer underlying the Seattle ANGS. Depending on the conditions encountered in the field, the location of the slug test may be changed with the approval of ANG/CEVR. Slug tests are performed by effecting an "instantaneous" rise or drop in the water level in the well, and monitoring the rate that the water level in the well returns to initial, undisturbed conditions. A rise in the water level may be effected by adding water or introducing a displacement slug. A drop may be effected by removing a volume of water or a displacement slug (note: if a displacement slug is used to effect a water level drop, the well must have recovered 100 percent from the water level rise that occurred upon insertion of the slug prior to removal of the slug). Slug testing at Seattle ANGS will be accomplished using a rising head slug test with a displacement slug.

A transducer and data recorder will be used to record water level data during the slug test. Hand water level measurements will be taken several times prior to the start of the test and during the test as a check on the data recorder. After introduction of the displacement slug, measurements will begin. For each measurement, both the water level measurement and the elapsed time since the start of the test will be recorded. Ideally, the test is completed when the monitoring well has returned to the static water level. If the water level has not recovered to static within 30 minutes, the test will be considered satisfactory if at least 50 percent recovery has been achieved. If it has not been achieved, then additional measurements will have to be taken. The time interval for the additional measurements may be estimated by plotting the recovery data collected as a Hvorslev type graph: displacement (logarithmic y-axis) versus time (arithmetic x-axis). A straight line should fit the data. Project the line and estimate appropriate times for subsequent measurements to ensure sufficient data collection.

A static water level should be measured less than 1 minute from the start of the test. The water level recorder should start approximately 5 seconds prior to the insertion of the slug into the monitoring well. Measurement frequency for the data recorder will be as follows:

Elapsed Time	Frequency of Measurement
0 to 1 minute	10 seconds
1 to 5 minutes	30 seconds
5 to 10 minutes	1 minute
10 to 30 minutes	5 minutes
30 to 60 minutes	10 minutes
1 to 4 hours	30 minutes

The data collected will be analyzed to determine the hydraulic conductivity of the aquifer at the well site. Analysis will be performed by one of the following three methods identified as appropriate for the hydrogeologic conditions at the monitoring well:

- Hvorslev Method (general conditions);
- Bouwer and Rice method (water table conditions); or
- Cooper and Papadopolus Method (fully penetrating the monitoring well through a confined aquifer).

7.1.8 Groundwater Monitoring

Groundwater monitoring will be performed during four quarters over one annual cycle in order to allow: 1) calculation of site-specific background concentrations; and 2) comparison of background groundwater data to groundwater data collected downgradient from IRP Site 1- Burial Site.

Discussions with a WDOE representative indicate that Chapter 173-340-720 (8)(a) of the Washington Administration Code states that samples for trace metal analysis should not be filtered unless filtration will yield a sample that is more representative of groundwater conditions. During the initial sampling round, data will be collected to determine the representativeness of filtered versus unfiltered groundwater samples. Both filtered and unfiltered groundwater samples collected from the three existing SI monitoring wells will be analyzed for PP trace metals, beryllium, and copper. Samples will be screened in the field for the presence of colloidal and suspended particulate matter using a turbidity meter. The results of the field screening and laboratory analysis from the initial sampling round will be used to determine if groundwater sample field filtering should be performed during subsequent RI monitoring rounds. If suspended particulate matter exists in the groundwater samples, it can be inferred that filtered groundwater samples are more representative of actual groundwater conditions.

Groundwater samples collected from monitoring wells during the remaining monitoring rounds will be submitted to a State-certified analytical laboratory for analysis of TPH, VOCs, SVOCs, PP trace metals, beryllium, copper, and radionuclides (gross alpha, gross beta, radium-226, and radium-228).

EPA Methods to be used during the analysis of monitoring well groundwater samples are presented in Section 6.0.

7.1.9 Photographic Records

Field activities will be documented with photographs. Photographs will be taken of activities at each study site showing borehole drilling, soil sampling, and the installation of monitoring wells. Photographs will also be taken to show the clarity of water produced by each of the RI monitoring wells at the end of the well development process. One set of annotated photographs will be provided to ANG/CEVR, if requested.

7.1.10 Optional Activities

Optional activities which may become necessary during the progress of the RI are discussed below.

7.1.10.1 Optional Soil Boring and Sampling

While performing RI field activities, additional soil borings and sampling may become necessary to further characterize soil chemical quality at the investigation site. If drilling additional soil borings becomes necessary, the Project/Site Manager will recommend the additional work as optional activities to the ANG/CEVR Project Manager including boring locations, sample types, and quantities. The ANG/CEVR Project Manager will respond to the recommendation within 24 hours to allow for approved optional activities to be incorporated into the ongoing investigations.

7.1.10.2 Optional Monitoring Well Installation

While performing RI field activities, the installation of additional monitoring wells may become necessary to further characterize groundwater chemical quality at the investigation site. If installing additional monitoring wells becomes necessary, the Project/Site Manager will recommend the additional work as an optional activity to the ANG/CEVR Project Manager including boring locations, sample types, and quantities. The ANG/CEVR Project Manager will respond to the recommendation within 24 hours to allow for approved optional activities to be incorporated into the ongoing investigation.

7.1.10.3 Optional Aquifer Testing

If the hydraulic conductivity of the aquifer is high enough to prevent successful slug testing, then an aquifer test should be performed at monitoring well MW-3. A short-term, constant rate aquifer test would be performed over a two-how period, or until pumping water level in the monitoring well has stabilized. Water level drawdown and recovery data collected during the test will be used, along with pumping rate, to estimate aquifer transmissivity.

7.2 Field Screening

Surface and subsurface soil and sediment samples will be screened using a PID and using a field TPH test kit. The following sections describe field screening methods.

7.2.1 Photoionization Detector

PID screening will be performed to determine the concentration of organic vapor in soil samples collected during RI field activities. Soil samples for PID screening will be placed in self-sealing bags and left to equilibrate for at least 15 minutes prior to measurement of organic vapor concentration. If at all possible, the bags containing the samples should be placed in full sunlight. The PID measurement will be taken by carefully opening the bag and immediately inserting the PID measurement probe. The maximum PID reading will be noted and recorded on the soil sampling field form.

7.2.2 Total Petroleum Hydrocarbons

Field screening of TPH in soils will be performed to provide data to guide field decision making regarding optional additional sampling and samples to be submitted for laboratory analysis. TPH field screening will be accomplished using an immunoassay method (EPA Method 4030). This method is designed to semiquantitatively detect the presence of TPH in soil extracts and provides results that can be generally correlated with fixed laboratory results using EPA Method 8015 modified. The test kit allows the screening of the presence of fuels (e.g., heating oil, gasoline, aviation fuel, diesel, and kerosene) in soil samples at specified action levels within two sensitivity ranges depending on the sample volume added.

Petroleum hydrocarbons are extracted using reagent grade methanol. The extractant is then placed in test tubes containing antibodies, substrates, and enzymes. A reaction is allowed to take place for a specific time period after which it is stopped by adding a dilute acid. A color reaction takes place within the test tube that is used to measure the quantity of TPH in the sample.

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SECTION 8.0

SAMPLE COLLECTION PROCEDURES

Procedures used for collecting soil and groundwater samples will follow Standard Operating Procedures developed for ERM's IRP program work and will conform to ANG/CEVR investigation protocols. Standard Operating Procedures are included in ERM's IRP Program Quality Assurance Program Plan (IRP QAPP, Appendix B; ERM, 1995). The Project/Site Manager is responsible for ensuring that samples are collected with properly decontaminated equipment and contained in properly cleaned sample containers. The steps required for sample control and identification, data recording, and chain-of-custody documentation are in the site-specific QAPP included in Appendix D of this work plan.

8.1 Surface Soil and Sediment

Surface soil samples will be collected using a hand-auger unit equipped with brass sampling tubes. Storm sewer sediment samples will be collected using a stainless steel trowel or scoop. Equipment used during soil and sediment sampling will be decontaminated between sampling locations as specified in this work plan.

8.2 Subsurface Soil

Subsurface soil samples will be collected using a split-spoon sampler and hollow-stem auger drill rig. The split-spoon sampler will be constructed of stainless-steel and equipped with brass sampling tubes.

Once the equipment decontamination procedures have been met, soil sampling will be conducted in each borehole.

Continuous drive samples will be collected using the split-spoon drive sampler from the interval between land surface to the target total depth. The lower-most or least disturbed split-spoon sleeve from each sample interval will be immediately sealed upon collection using a teflon barrier, aluminum foil (shiny side up), and plastic end cap. This sample will be designated for potential laboratory analysis. One or more of the remaining split-spoon sleeves from each drive sample interval will be field-screened using a PID and TPH test kits.

ANG Site Investigation Protocol requires that two soil samples be collected from each borehole for off-site laboratory analysis. The two samples will be the shallowest and deepest sample at each boring location. An optional third sample will be collected at the intermediate depth if field screening results indicate the presence of organic vapors, elevated TPH, or visual analysis indicates staining.

8.3 Groundwater

Groundwater samples will be collected during RI field activities from monitoring wells and from Geoprobe™ boreholes using a Hydropunch™ tool.

8.3.1 Monitoring Well Sampling

Groundwater samples will be collected from all monitoring wells installed during the RI and SI at Seattle ANGS. A minimum of three borehole volumes will be evacuated using a nondedicated submersible pump. Groundwater samples will be collected directly from the discharge port of the pump.

The following procedures will be utilized during groundwater sampling activities at new and existing monitoring wells:

- Groundwater samples will not be collected until at least 2 days after the development of new monitoring wells to allow water in the wells to reach equilibrium.
- Immediately prior to collecting a sample, the static water level will be measured with reference to the monitoring well's measuring point and will be recorded in the field notebook.
- Whenever feasible, monitoring wells will be sampled in order of increasing level concentration of contaminants, based on analysis of samples collected during previous sampling rounds.
- Prior to collecting a sample, the volume of water in the screen and monitoring well casing will be purged three times. If the monitoring well yield is sufficient, additional well volumes may be removed until the temperature, specific conductance, turbidity, and pH of the monitoring well have stabilized. Monitoring wells that

recharge extremely slow will be purged dry, allowed to recharge, and purged again. The amount of fluid purged will be measured and recorded.

- Monitoring wells will be sampled directly from the pump discharge. A decontaminated length of tubing will be used to collect the sample from the pump's discharge port.

- All sampling equipment will be kept off contaminated soil to prevent cross-contamination of the samples (e.g., equipment will be placed on polyethylene plastic sheeting).

Static and pumping water levels will be measured in monitoring wells using an electric water level indicator. The electric water level tape will be decontaminated prior to use by rinsing with deionized water. If free product is present in the monitoring well, the equipment will be washed in an Alconox and water solution and double rinsed (tap water followed by deionized water). Groundwater level measurements will be taken coincident with groundwater sampling at the initial RI field activities and during subsequent quarterly monitoring activities.

8.3.2 Hydropunch™ Sampling

Soil samples collected during Geoprobe™ installation will be used for lithologic analysis only. Groundwater samples will be collected using a Hydropunch™ groundwater sampling tube comprised of a stainless steel drive point, perforated section of stainless steel pipe for sample intake, a stainless steel and teflon sample chamber, and an adapter to attach the unit to a Geoprobe™ rod. The unit is pushed through the soil to the desired sampling depth. The sampler is then retracted allowing groundwater to flow through the screen and into the sample chamber. Once the chamber is filled, the Hydropunch™ sampling tube is pulled toward the surface. Upon retrieval at the surface, the drive cone is removed and a sample discharge device is inserted for transferring the groundwater sample to the sample container. Equipment used during Geoprobe™/Hydropunch™ sampling will be decontaminated between sampling locations as specified in this work plan.

8.4 Land Surveying

All new soil borings and monitoring wells at Seattle ANGS will be surveyed by a State-licensed surveyor to define their locations and elevations for future reference. All surveying will be tied to a permanent marker on or near the Seattle ANGS (e.g., bench mark, manhole cover, fire hydrant, or bridge abutment). This permanent marker will be tied to the National Geodetic Vertical Datum Mean Sea Level. All positions and coordinates at all permanent points within the control traverse will be documented.

All new soil borings and monitoring wells will be established with a horizontal accuracy of ±0.1 foot and a vertical accuracy of ±0.01 foot.

8.5 Field Parameters

The following subsections summarize procedures to be used to collect data for the following field parameters: organic vapors content, temperature, pH, specific conductance, and turbidity.

8.5.1 Air Monitoring

During all drilling activities, a PID will be used to monitor the breathing zone for organic vapors to determine the need for respiratory protection. Specific monitoring details and action levels are discussed in Appendix A, the SSHP.

8.5.2 Temperature Measurement

The temperature of the water will be measured using an electronic digital or analog thermometer that has been decontaminated prior to each use. Decontamination will be achieved by rinsing with deionized water.

8.5.3 pH Measurement

The pH of the water will be measured using a portable pH meter. The meter will be calibrated daily using buffer solutions of the appropriate range of expected pH values. The meter will also be recalibrated periodically during periods of continued use as recommended by the manufacturer. The pH meter probe will be decontaminated prior to each use by rinsing with deionized water.

8.5.4 Specific Conductance Measurement

The specific conductance of the water will be measured with a portable specific conductance meter. A standard potassium chloride solution will be used to calibrate the instrument daily. The meter will also be recalibrated periodically during periods of continued use as recommended by the manufacturer. The specific conductance meter probe will be decontaminated prior to each use by rinsing with deionized water.

8.5.5 Turbidity Measurement

Turbidity of the water will be measured with a portable turbidity meter. A standard formazin solution will be used to calibrate the instrument daily. The meter will also be recalibrated periodically during periods of continued use as recommended by the manufacturer. The turbidity meter probe will be decontaminated prior to each use by rinsing with deionized water.

8.6 Field Quality Control

Field duplicate samples, and field and trip blanks will be submitted to the analytical laboratory to provide the means to assess the quality of the data resulting from the field sampling program. Field and trip blank samples will be analyzed to check for contamination associated with sampling procedures and/or ambient conditions at the site. Duplicate samples will be submitted using nonindicative sample identifiers to provide a QA check on analytical procedures and results. A more complete description of field QA/QC procedures is included in Appendix D.

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SECTION 9.0

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The following sections provide a preliminary summary of key ARARs that may be relevant to RI activities at Seattle ANGS.

9.1 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Section 121 (d) of CERCLA as amended by SARA of 1986, addresses the management of Federal facilities. The IRP has been designed to mirror site investigation requirements under CERCLA (PA/SI/RI/FS/RD/RA).

9.2 Resource Conservation and Recovery Act (RCRA)

Federal RCRA regulations governing hazardous waste management provide both action- and chemical-specific ARARs that may apply to IRP activities at Seattle ANGS.

9.2.1 Waste Identification

Materials excavated or removed from the site (i.e., drill cuttings, contaminated soil, and contaminated groundwater) are regulated as hazardous waste if they meet the Federal definition provided in 40 Code of Regulations (CFR) 261.

9.2.2 Waste Generation and Transport

RI activities or remedial alternatives involving the movement or removal of hazardous waste trigger RCRA hazardous waste generator requirements provided in 40 CFR 262. When hazardous waste is shipped off site in regulated amounts, the manifesting and transport procedures in 40 CFR 263 must be followed. As applicable, the Seattle

ANGS environmental coordinator will sign all hazardous waste manifests as the generator of the waste.

9.2.3 Land Disposal Restrictions

RCRA regulations in 40 CFR 268 set forth Land Disposal Restrictions (also known as Land Ban Requirements) for RCRA wastes. These restrictions were required by the RCRA Hazardous and Solid Waste Amendments of 1984 to prohibit the continued land disposal of hazardous wastes beyond specified dates. However, wastes treated in accordance with chemical-specific treatment standards provided in 40 CFR 268 Subpart D may be land-disposed as provided therein. The Land Disposal Restrictions potentially affect the storage and disposal of hazardous wastes generated during RI or subsequent remedial activities and may be considered both action- and chemical-specific ARARs.

9.2.4 Treatment, Storage, and Disposal Facilities

If remedial alternatives for the site involve the construction or off-site use of RCRA treatment, storage, or disposal facilities, regulations provided in 40 CFR 264 become action-specific ARARs. Various subsections of 40 CFR 264 govern standards and procedures for the operation of hazardous waste treatment, storage, or disposal facilities. For example, a common disposal practice is to create a waste pile of contaminated soil as part of the remediation process. 40 CFR 264 Subpart L promulgates Federal RCRA standards for waste piles, including their design, operating requirements, monitoring and inspection, closure, and post-closure care. Other subparts control tank systems, surface impoundments, land treatment units, landfills, incinerators, and miscellaneous treatment, storage, or disposal units.

9.3 Safe Drinking Water Act

Federal regulations pursuant to the Safe Drinking Water Act govern the quality, usage, and discharge of groundwater. Maximum contaminant levels (MCLs) specified in 40 CFR 141.11-141.16 are legally enforceable Federal drinking water standards established by EPA. Maximum contaminant level goals (MCLGs) specified in 40 CFR 141.50-141.51 are nonenforceable, health-based goals for drinking water. MCLGs are set at levels at which no adverse health effects may arise. MCLs are set as close as practical to MCLGs. For noncarcinogens, MCLs are nearly always set at the MCLG. These ARARs may be used to identify a range of target cleanup levels for groundwater at Seattle ANGS.

9.4 Clean Water Act

The Federal Clean Water Act and pursuant regulations provide potential location-, chemical-, and action-specific ARARs for IRP activities at Seattle ANGS.

9.4.1 Ambient Water Quality Criteria (AWQC)

EPA has promulgated Ambient Water Quality Criteria (AWQC) for surface and groundwater through 40 CFR 131. Aligned with Federal Clean Water Act criteria, the standard governing AWQC presents scientific data and guidance on the environmental effects of pollutants, rather than only establishing regulatory requirements. As a result, decision-makers evaluating remedial alternatives may compare their water quality data to Federal data and guidance. Candidate remedial actions involving contaminated surface water or groundwater must be evaluated within the context of follow-on water usage and the circumstances of the actual or potential release before implementation. As a general statement, AWQC are applied when evaluating cleanup levels for groundwater. Table 9-1 lists State of Washington Groundwater Standards.

9.4.2 National Pollutant Discharge Elimination System (NPDES)

National Pollutant Discharge Elimination System (NPDES) regulations govern discharges to surface water and control surface water runoff from Station stormwater discharge systems. Promulgation of Clean Water Act Section 402 and formal ARARs are established for NPDES through 40 CFR 122 and 40 CFR 125, and provide action- and chemical-specific ARARs. The discharge of development water or produced water from monitoring wells will be in accordance with NPDES regulations.

9.5 Occupational Safety and Health Act

All site operations are governed by Occupational Safety and Health Act standards under 29 CFR 1910. The Health and Safety Officer for the RI/FS field investigation will ensure that all site workers meet the

TABLE 9-1

Washington Groundwater and Soil Remediation Standards
143rd CCSQ, Seattle ANGS, Seattle, Washington

	GROUNDWATER Concentration in µg/l				SOILS Concentration in mg/kg	
ANALYTICAL GROUP	Primary MCL	Secondary MCL	MTCA - Method A	MTCA - Method B	MTCA - Method A Residential/Industrial	MTCA - Method B
VOLATILE ORGANIC COMPOUNDS (VOCS)						
Benzene	5	–	5.0	**1.5**	0.5 / 0.5	34.5
Bromodichloromethane	100*	–	–	**0.7**	–	16.1
Bromoform	100*	–	–	5.5	–	127
Bromomethane	–	–	–	11.2	–	112
Carbon disulfide	–	–	–	800	–	8000
Carbon tetrachloride	5	–	–	**0.33**	–	7.7
Chloroform	100*	–	–	7.17	–	164
Chlorobenzene	100	–	–	160	–	1600
Ethylbenzene	700	–	30	800	20 / 20	8000
Methylene chloride	5	–	5	–	0.5 / 0.5	–
Toluene	1,000	–	40	1600	40 / 40	16000
Trichloroethylene	5	–	5	**3.98**	0.5 / 0.5	90.9
Tetrachloroethylene	5	–	5	**0.86**	0.5 / 0.5	19.6
Trihalomethanes (total)	100*	–	–	–	–	–
1,2-Dichloroethane	5	–	5	**0.48**	–	11
cis-1,2-Dichloroethylene	70	–	–	80	–	800
trans-1,2-Dichloroethylene	100	–	–	160	–	16000
1,1-Dichloroethylene	7	–	–	**0.07**	–	1.67
Styrene	100	–	–	**1.46**	–	33.3
1,2-Dichloropropane	5	–	–	**0.64**	–	14.7
1,1,2,2-Tetrachloroethane	–	–	–	**1.68**	–	38.5
1,1,1-Trichloroethane	200	–	200	7200	20 / 20	72000
Vinyl Chloride	2	–	0.2	**0.02**	–	0.53
1,1,2-Trichloroethane	5	–	–	**0.77**	–	17.5
Xylenes (total)	10,000	–	20	16000	20 / 20	160000
Monochlorobenzene	100	–	–	–	–	–
1,3-Dichlorobenzene	75	–	–	–	–	–
1,4-Dichlorobenzene	600	–	–	**1.8**	–	41.7
SEMIVOLATILE ORGANIC COMPOUNDS (SVOCS)				–	–	–
PAHs (carcinogenic)	–	–	0.1	0.012	1 / 20	–
PETROLEUM HYDROCARBONS						
TPH (gasoline)	–	–	1,000		100 / 100	–
TPH (diesel)	–	–	1,000		200 / 200	–
TPH (other)	–	–	1,000		200 / 200	–
POLYCHLORINATED BIPHENYLS (PCBs)						
PCB Mixtures	–	–	0.1	0.009	1 / 10	0.112
METALS						
Arsenic	50	–	5	**0.05**	20 / 200	1.43
Barium	2,000	–	–	1120	–	5600
Beryllium	4	–	–	**0.02**	–	0.233
Cadmium	5	–	5	8	2 / 10	–
Chromium (total)	100	–	50	–	100 / 500	–
Copper	–	–	–	592	–	2660
Lead	–	–	5	–	250 / 1000	
Mercury (inorganic)	2	–	2	4.8	1 / 1	24
Selenium	50	–	–	80	–	400
Silver	–	100	–	80	–	400
RADIONUCLIDES						
Gross Alpha Particle (pCi/l)	15	–	15	–	–	–
Radium-226	3	–	3	–	–	–
Combined Radium-226 & Radium-228	5	–	5	–	–	–
Gross Beta Particle**	50	–	4	–	–	–

Sources: WDOE, 1993 and 1994

µg/l = micrograms per liter

mg/kg = milligrams per kilogram

– = Not available

MCL = Federal Maximum Contaminant Level

* MCL for total trihalomethanes including bromoform, bromodichloromethane, chloroform, and dibromochloromethane

** Limit on average annual concentration

MTCA Method A/B = Model Toxics Control Act

TPH = Total Petroleum Hydrocarbons

PAHs = Polyaromatic Hydrocarbons

pCi/l = picoCuries per liter

bolded = PQL is greater than cleanup standards requirements of the health and safety plan, possess and use all personal protective equipment, and take all precautions to eliminate exposure to unsafe or unhealthy situations. Other applicable Occupational Safety and Health Act ARARs include health and safety for Federal service contracts (29 CFR 1926) and recordkeeping and reporting under 29 CFR 1904.

9.6 Hazardous Materials Transportation Act

If material containing hazardous wastes is to be transported off site, the United States Department of Transportation hazardous material transportation requirement in 49 CFR 171-179, pursuant to the Federal Hazardous Materials Transportation Act, may be action-specific ARARs for RI activities. These requirements are supplemental to RCRA transporter requirements in 40 CFR 263.

9.7 Clean Air Act

The Federal Clean Air Act may provide action- and chemical-specific ARARs for IRP activities, including subsequent field investigations and remedial actions, which include soil excavation or incineration. All remediation activities must comply with National Primary and Secondary Ambient Air Quality Standards found in 40 CFR 50. Rules governing particulate matter less than 10 microns in size are contained in 40 CFR 50, and are important from the potential detrimental effects of such particles on the lungs. All field activities involving air emissions must ensure compliance with the 10 microns in size standard.

9.8 Federal Guidance To Be Considered

In addition to Federal and State requirements that may be ARAR to IRP activities, Federal nonregulatory criteria must be considered. Chemical-specific Federal nonregulatory criteria, used to help characterize risks and to set cleanup goals, include the following:

- EPA Risk Reference Doses;
- EPA Health Advisories;
- EPA Carcinogen Assessment Group Potency Factors;

- EPA Acceptable Intake Values, Chronic and Subchronic; and
- EPA guidance manual on water-related fate of 129 priority pollutants.

9.9 State Requirements

State of Washington has a toxic waste cleanup law entitled MTCA. MTCA outlines cleanup requirements to ensure the protection of human health and the environment while allowing flexibility in site-specific application of these requirements. MTCA defines a two-step approach for establishing cleanup requirements for individual sites. The first step is establishing cleanup standards and the second step is selecting cleanup actions that would best achieve the cleanup standards. The following summary of options for selecting cleanup levels is derived from WDOE (1993).

MTCA provides three options for establishing site-specific cleanup levels. Each of these options uses human health risk as the main determinant in setting cleanup levels.

9.9.1 Model Toxics Control Act Method A

Method A defines cleanup levels for 25 common contaminants (Table 9-1). This method is designed to be used at sites that are relatively small or straight-forward or include only a few contaminants. All of the contaminants found at such sites must be listed in the Method A tables.

9.9.2 Model Toxics Control Act Method B

Method B cleanup levels are developed using a site risk assessment that focuses on site characteristics, such as how the contaminants interact, what the combined health effects of the contaminants may be, and how the contaminants movement on site and off site could threaten human heath and the environment. This method is the most common one used for setting cleanup levels when sites are contaminated with substances not listed under Method A and environmental factors make site cleanup difficult. Natural background concentrations of a contaminant can be used when establishing cleanup levels.

The risk level for individual contaminants identified as carcinogens cannot exceed 1×10^{-6}. If more than one type of contaminant is present, the total risk level cannot exceed 1×10^{-5}. Concentrations of noncarcinogens cannot exceed a combined hazard index of 1.

9.9.3 Model Toxics Control Act Method C

This method is similar to that of Method B. The main difference is that the lifetime cancer risk for carcinogen contaminants is set at 1×10^{-5} for both individual contaminants and the total risk caused by all substances on a site. This method is used when cleanup levels under Method A or B are technically impossible to achieve; are lower than background concentrations; or may cause more environmental impacts than benefits. Use of this method requires proof to WDOE that the cleanup levels will protect human health and the environment.

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SECTION 10.0

CONTAMINANT FATE AND TRANSPORT

Data collected during the RI regarding site physical characteristics and contaminant source characteristics are combined in the analysis of contaminant fate and transport.

The following items will be addressed as part of the fate and transport evaluation:

- Potential routes of migration;
- Contaminant persistence;
- Contaminant mobility and potential migration in soil and groundwater; and
- Location and characteristics of potential receptors.

Studies published in scientific literature will be used to evaluate contaminant persistence and potential for migration. Site-specific soil and groundwater data will be used to evaluate the applicability of the results of published studies to environmental conditions at Seattle ANGS.

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SECTION 11.0

BASELINE RISK ASSESSMENT

The State of Washington has developed human health risk assessment procedures to be used in establishing site-specific cleanup levels for contaminants. Appendix C contains the applicable sections of MTCA that address risk assessment procedures. The following subsections provide a summary of risk assessment processes and procedures.

11.1 Purpose of the Baseline Risk Assessment

A Baseline Risk Assessment provides an evaluation of the potential threat to human health and the environment (i.e., biological receptors) in the absence of any remedial action. The assessment provides the basis for determining whether or not remedial actions are necessary and the justification for performing remedial actions. A screening level Baseline Risk Assessment will be performed for Sites at Seattle ANGS. Evaluations described in the following subsections will be included in the screening level Baseline Risk Assessment.

11.2 Identification of Contaminants of Concern

Contaminants of concern will be identified at each site in order to focus subsequent efforts in the risk assessment process. A contaminant of concern may be selected for one of the following reasons: intrinsic toxicological properties; a presence at high concentrations or in wide-spread areas; and/or the potential of the compound to migrate into critical exposure pathways (e.g., drinking water). In the event that multiple contaminants are found to be present at a site, a subset or indicator contaminant may be selected for further analysis. The subset will include those contaminants that pose the greatest potential risk. The contaminants selected for further hazard identification will be selected based on concentration and/or quantity, toxicity, detection frequency, mobility, persistence, and concentration relative to local background.

11.3 Toxicity Assessment

The toxicity assessment requires collection of available data regarding the potential for particular contaminants to cause adverse effects in exposed individuals. This information is used in conjunction with total exposure estimates to determine the relationship between the extent of exposure to a contaminant and the increased likelihood and/or severity of adverse effects in the exposed individual. The toxicity assessment will rely heavily on existing toxicity information in scientific literature and will not involve the development of new data on toxicity or dose-response relationships. WDOE publishes an annual update of toxicological data to be used in calculating cleanup levels under MTCA. The most recently-available update from WDOE will be used in performing the toxicity assessment.

11.4 Risk Characterization and Exposure Assessment

The final component of the risk assessment process is a characterization of the potential risks of adverse health or environmental effects from contaminants found to be present at a site or migrating from a site. The Baseline Risk Assessment will include the following:

- Identifying potential receptors that may be at risk.
- Identifying exposure pathways, that is, identifying how contaminants may migrate from a source to an existing or potential point of human contact.
- Quantifying potential exposure, that is, estimating magnitude, frequency, and duration of the exposure.

During the risk assessment, follow up will be performed to definitely locate the day care center identified in EDR's environmental database report. Additionally, ERM will further evaluate the location and current status of water supply wells identified by OpTech within a 4-mile radius of the Seattle ANGS.

MTCA specifies that cleanup levels shall be based on estimates of current and future resource uses and reasonable maximum exposures expected to occur under both current and potential site use conditions. Because individual or groups of individuals may be exposed to contaminants by more than one exposure pathway, the reasonable maximum exposure will take into account the total exposure through all of the exposure pathways. Appendix C contains additional details pertaining to performing exposure assessments under MTCA.

The results of the screening level risk characterization may indicate that a site poses little to no threat to human health or the environment. In such a situation, the FS will be either scaled down as appropriate to that site and its potential hazard or eliminated altogether. The results of the RI and the screening level Baseline Risk Assessment will therefore serve as the primary means of documenting a no further action recommendation.

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SECTION 12.0

FEASIBILITY STUDY

The following sections summarize the basic content of an FS, as described in the EPA guidance document *Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA* (EPA, 1988).

12.1 Purpose and Organization

The FS is for the purpose of developing and screening remedial alternatives for contaminated media identified during the RI. A focused feasibility study (FFS) approach will be applied if site conditions are favorable. EPA guidance entitled *Presumptive Remedies: Policy and Procedures* (EPA, 1993) outlines the elements of an FFS.

12.2 Development of Alternatives

The primary objective of this phase of the FS is to develop an appropriate range of waste management options that will be analyzed fully in the detailed and comparative analysis phase of the FS. Potentially applicable treatment technologies and process options for site remediation will be identified for both soil and groundwater. Potential remedial technologies will be gathered from EPA documents, various research documents, and private industry documents. Also, experts in various fields of remedial technologies from both government and the private sector will be consulted, as necessary, concerning the appropriateness of a technology for the site.

12.3 Preliminary Screening of Remedial Alternatives

The screening criteria, which will be used to assess the remedial alternatives, are effectiveness, implementability, and relative cost. Remedial technologies will be evaluated in a two-step process. The first step assesses the applicability of a particular remedial technology and process option for site conditions. Each alternative will be evaluated based on the physiography, geologic, and hydrogeologic conditions at the IRP site. Those remedial technologies and process options that cannot be accomplished at the site will be eliminated as not applicable. Those remedial technologies and process options that are potentially applicable to the site will be further assessed in terms of their effectiveness in achieving the remedial action objectives, ease of implementation, relative capital costs, and operation and maintenance.

The category of implementability addresses the ability of the process option to be implemented based on factors such as institutional restraints, site conditions, types of contaminants to be treated, and the degree of difficulty in designing a viable process. Capital and operation and maintenance costs will be categorized as low, moderate, or high within each type of remedial technology.

12.4 Detailed Analysis of Alternatives

Detailed analysis of alternatives will follow the development and screening of alternatives and will precede the actual selection of a remedy. The National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR 300.430 (iii) sets forth nine criteria to be used for a detailed and comparative analysis of the alternatives retained after the screening portion of the FS. The nine criteria which will be used for detailed and comparative analysis of the remedial alternatives are as follows:

- Overall protection of human health and the environment;
- Compliance with ARARs (i.e., standards, criteria, or limits promulgated under Federal or State law);
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability;
- Cost;
- State acceptance; and

- Community acceptance.

12.5 Comparative Analysis of Alternatives

Once the alternatives have been described and individually assessed against the criteria, a comparative analysis will be conducted to evaluate the relative performance of each alternative in relation to each specific evaluation criterion. This is in contrast to the preceding analysis in which each alternative is analyzed independently without consideration of other alternatives. The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another so that the key tradeoffs that must be balanced are identified. Overall protection of human health and the environment and compliance with ARARs will generally serve as threshold determinations in that they must be met by any alternative in order for it to be eligible for selection.

12.6 Recommendations

An FS Report will be prepared to document the development and analysis of alternatives. It will include background information about the site based on the RI Report, the remedial action objectives for soil and/or groundwater, the estimated volume or area of soil and/or groundwater to which remedial alternatives will be applied, and the description of development, screening, and detailed and comparative analysis process of remedial alternatives and process options.

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SECTION 13.0

EQUIPMENT DECONTAMINATION PROCEDURES

All nondedicated sampling equipment will be decontaminated prior to use and between sample collection. Standard decontamination procedures call for scrubbing sampling equipment with a laboratory-grade detergent (such as Liqui-Nox or Alconox), followed by a rinse with potable water, a rinse by ASTM Type II reagent water, and a rinse by pesticide-grade methanol. All equipment is wrapped in aluminum foil (shiny side outward) after completion of the decontamination process or positioned to preclude inadvertent contamination prior to reuse.

All drilling equipment will be decontaminated away from the monitoring well site in the designated decontamination area. Steam is used for decontamination prior to drilling and between drilling sites. The Project/Site Manager is responsible for ensuring that the decontamination area is kept clean and orderly. All decontaminated equipment and unused construction materials will be removed from the site.

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SECTION 14.0

BOREHOLE ABANDONMENT PROCEDURES

Once drilling has been completed and soil has been sampled at each boring, the boring shall be abandoned by grouting. Grout will be introduced by a tremie into the bottom of the open boring and filled to the surface. The grout mix will be approximately one sack (94 pounds) Portland cement, approximately 5 pounds powdered bentonite, and approximately 8 gallons water. The bentonite powder and water will be mixed prior to the addition of cement.

Following completion of all drilling activities, ERM will ensure that the site is restored as closely as possible to its pre-investigation condition.

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SECTION 15.0

INVESTIGATION DERIVED WASTE HANDLING PROCEDURES

Decontamination fluids and purge water generated during drilling and sampling activities will be contained in segregated 55-gallon drums. The contents of the drums will be sampled using disposable Teflon bailers and sent for laboratory analysis. Decontamination fluids determined by laboratory analysis not to contain regulated or hazardous materials will be either discharged to the sanitary sewer after approval from the City of Seattle or removed for disposal by a licensed contractor.

The disposal of soil- and groundwater-containing materials determined to be regulated or hazardous is not included in the scope of this work plan. ERM will be responsible for collecting, sampling, characterizing, labeling, preparing manifests, and recommending appropriate and applicable methods of disposal or treatment of regulated or hazardous wastes generated during the RI. Seattle ANGS is ultimately responsible for disposal of all investigation-derived wastes.

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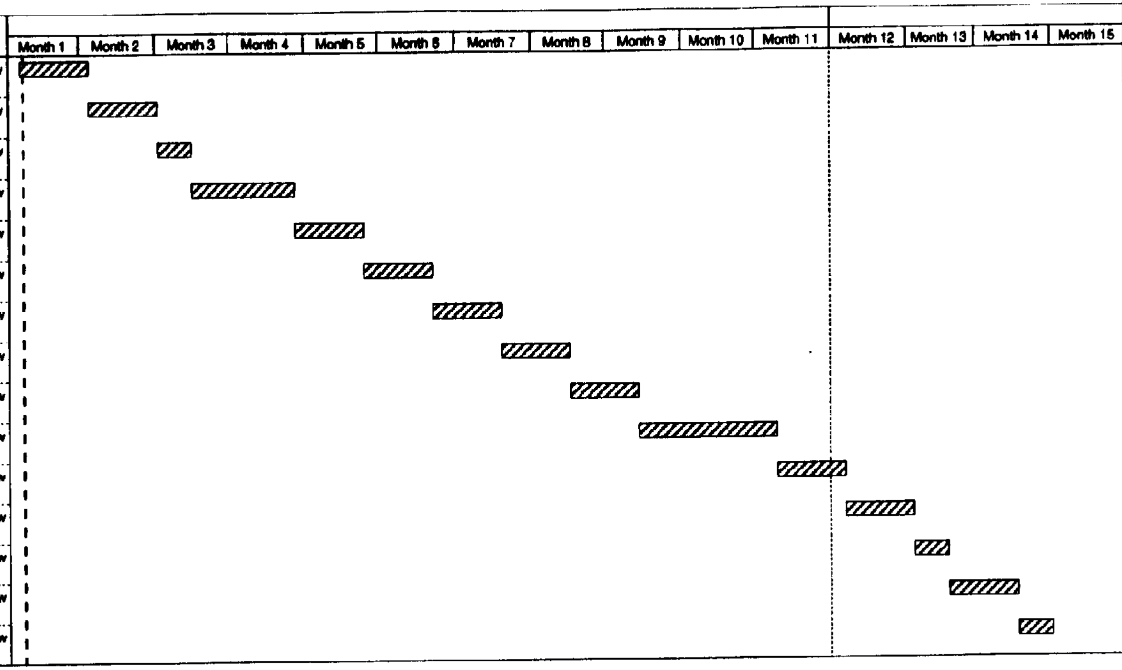
SECTION 16.0

PROJECT SCHEDULE AND DELIVERABLES

Figure 16-1 is the project timeline schedule for the Seattle ANGS RI/FS. The project is expected to start upon approval of the RI/FS work plan and spans the time from the Kickoff Meeting for the RI to the completion and submittal of the final FS Report. This schedule may be adjusted in the future due to the interdependency of the tasks involved in the project. Significant events that may effect the schedule are the ANG and State review of the various drafts of RI and FS Reports. Important milestones in the schedule are shown in Figure 16-1.

ID	Name	Duration
1	Prepare for Field Work	4w
2	Conduct Preliminary Sampling Round and Analyze Results	4w
3	Perform Remedial Investigation Field Work	2w
4	Review and Analyze Data	8w
5	Prepare and Submit Draft RI Report	4w
6	ANG Review of Draft RI Report	4w
7	Prepare and Submit Draft Final RI Report to Regulatory Agencies	4w
8	Regulatory Review of Draft Final RI Report	4w
9	Modify and submit Final RI Report	4w
10	Conduct FS	8w
11	Prepare and Submit Draft RI FS Report	4w
12	ANG Review of Draft FS Report	4w
13	Prepare and Submit Draft Final FS Report to Regulatory Agencies	2w
14	Regulatory Review of Draft Final FS Report	4w
15	Modify and submit Final FS Report	2w



Time, in months, since approval of Final RI/FS Work Plan.

FIGURE 16-1
RI/FS Timeline
143rd CCSQ, Seattle ANGS
Seattle, Washington

Project:
Date: 2/7/96

Critical | Noncritical | Progress | Milestone ◆ | Summary | Rolled Up ◇

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SECTION 17.0

REMEDIAL INVESTIGATION REPORT

17.1 Remedial Investigation Report Purpose

The purpose of the RI Report is to present a summary and interpretation of the investigative work performed during the RI.

17.2 Remedial Investigation Report Format

The RI Report will be prepared in accordance with the suggested ANG/CEVR report outline. The most current version of this outline is included in Appendix E of this work plan.

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SECTION 18.0

FEASIBILITY STUDY REPORT

18.1 Feasibility Study Report Purpose

The purpose of the FS Report is to present a summary of the screening, development, and detailed analysis of remedial alternatives for contaminated media identified at the Seattle ANGS.

18.2 Feasibility Study Report Format

The FS Report will be prepared in accordance with the suggested ANG/CEVR report outline. The most current version of this outline is included in Appendix E of this work plan.

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SECTION 19.0

REFERENCES

ERM-West, Inc., 1995, *Final Quality Assurance Project Plan, Air National Guard Installation Restoration Program*, February 1995.

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EPA, 1988, *Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. Office of Emergency and Remedial Response.

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WDOE, 1994, *Model Toxics Control Act Cleanup Levels and Risk Calculation (CLARC II) Update*, August 31, 1994.

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WDOE, 1995, *Guidance on Sampling and Data Analysis Methods*, Publication 94-49.

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Appendix A

APPENDIX A

SITEWIDE SAFETY AND HEALTH PLAN

EMERGENCY REFERENCES

Key Telephone Numbers

AMBULANCE	911
POLICE	911
FIRE	911
HOSPITAL	911
NATIONAL RESPONSE CENTER	1-800-424-8802
POISON CONTROL CENTER	1-800-682-9211
TOXLINE	1-301-496-1131
CHEMTREC	1-800-424-9300
ERM, WALNUT CREEK OFFICE	1-510-946-0455
ERM, PHOENIX OFFICE	1-602-990-9350
ERM, BELLEVUE OFFICE	1-206-462-8591
BASE SAFETY MANAGER Mstr. Sgt. Kimberly Arrison-Urban	1-206-764-5625

Nearest Hospital

Harborview Medical Center 1-206-223-3074
325 Ninth Avenue
Seattle, Washington

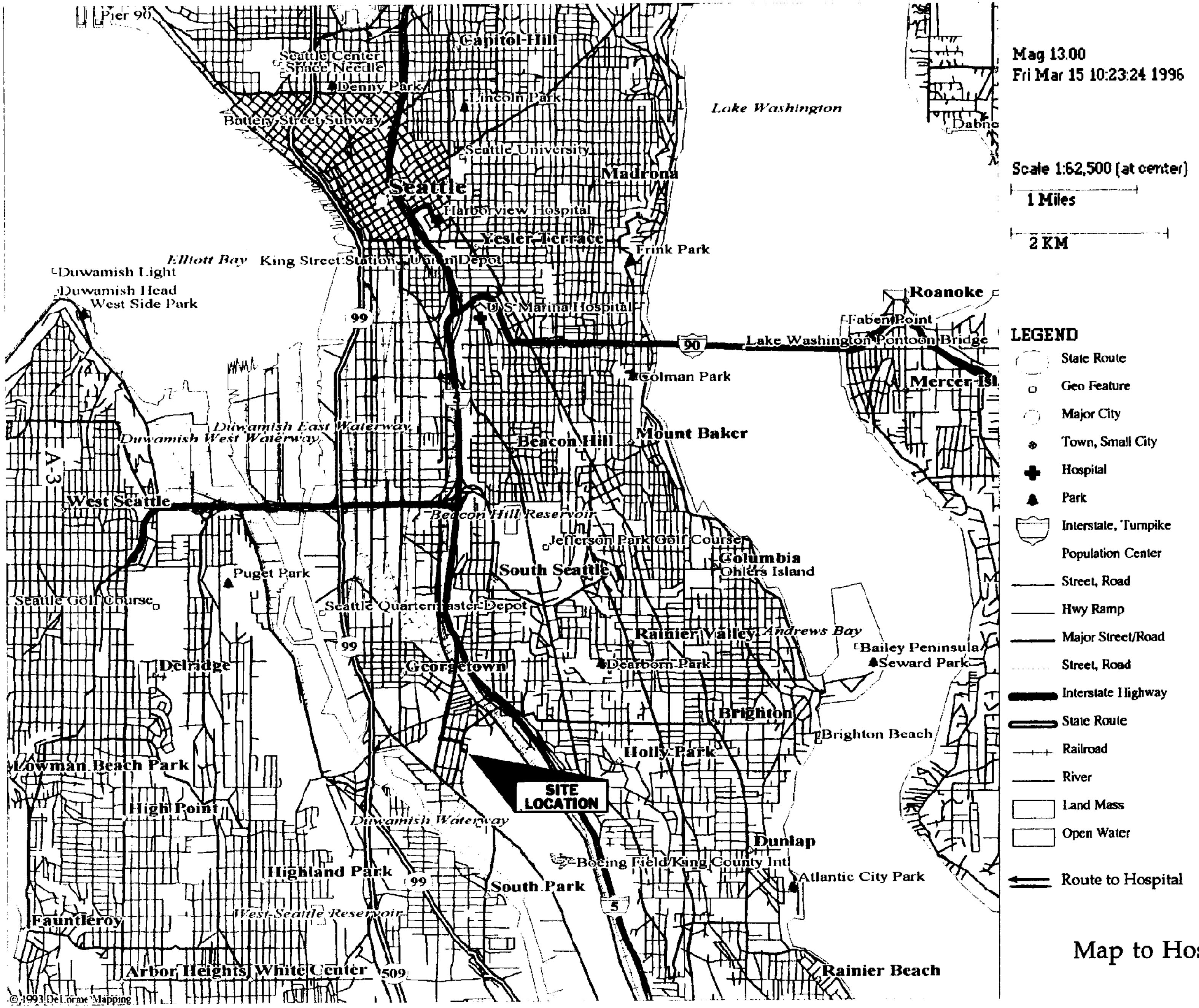
Directions to Hospital

Exit the Seattle ANGS through the main entrance. Turn right (north) onto Ellis Avenue. In one block, turn left (west) onto Warsaw Street.

In one block, turn north onto Corson Avenue, and follow signed lanes to Interstate 5. Enter Interstate 5 Northbound. Exit Interstate 5 at the James Street Exit (Exit 164) and exit the collector/distributor on the James Street off-ramp. Turn right (east) on James Street, follow 2 blocks to 9th Avenue. Turn right on to 9th Avenue, Harborview Hospital is on the right.

ERM Representatives

PROJECT/SITE MANAGER (Phoenix)	Robin G. Weesner
SITE HEALTH AND SAFETY OFFICER	To be assigned
DIRECTOR, HEALTH AND SAFETY	Steven Meyers, C.S.P., C.I.H.



Map to Hospital

KCSlip4 39142

SEA405672

DISCLAIMERS AND LIMITATIONS ON USE

ERM-West, Inc., ("ERM") developed the following Sitewide Safety and Health Plan (the "SSHP") for use by ERM personnel and by ERM subcontractors (individually, an "ERM Contractor" and collectively, "ERM Contractors") in connection with soil and groundwater investigation, monitoring, and remediation activities (the "Project") being performed by ERM for the Air National Guard Readiness Center (the "Client") at the Seattle Air National Guard Station in Seattle, Washington (the "Site"). ERM personnel must adhere to the practices and procedures specified in the SSHP.

Each ERM Contractor must review the SSHP and agree to accept and abide by the SSHP, subject to any modifications to the SSHP (to address the ERM Contractor's more stringent practices and procedures) agreed upon in writing by ERM and the ERM Contractor. The ERM Contractor shall indicate such acceptance by executing a copy of this notice of disclaimers and limitations on use as indicated below and returning it to ERM's project manager for the Project prior to its commencing work at the Site. However, if any ERM Contractor commences work at the Site, the ERM Contractor shall be deemed to have accepted the SSHP and the terms hereof and the failure to execute and return to ERM a copy of this notice shall not be relevant to such interpretation.

If a contractor or a person other than the Client, ERM employees and ERM Contractors (individually, a "Third Party" and collectively, "Third Parties") receives a copy of the SSHP, such Third Party should not assume that the SSHP is appropriate for the activities being conducted by the Third Party. NO THIRD PARTY HAS THE RIGHT TO RELY ON THE SSHP. EACH THIRD PARTY SHOULD ABIDE BY ITS OWN SSHP IN ACCORDANCE WITH ITS OWN PROFESSIONAL JUDGMENT AND ESTABLISHED PRACTICES.

ERM shall not be responsible for the implementation of any Third Party's safety program(s), except to the extent otherwise expressly agreed upon by ERM and a Third Party in writing. The services performed by ERM for the Client and any right of the Client and/or an ERM Contractor to rely on the SSHP shall in no way inure to the benefit of any Third Party, including, but not limited to, employees, agents, or consultants and subcontractors of ERM Contractors, so as to give rise to any cause of action by such Third Party against ERM.

The SSHP generated by ERM in connection with the Project is for use on a specific site and in connection with a specific project. ERM makes no representation or warranty as to the suitability of the SSHP for reuse on another site or as to the suitability of the SSHP for reuse on another project or for modifications made by the Client or a Third Party to the SSHP.

ERM Contractors Only

Agreed and Accepted:

Contractor's Name:____________________

By: ____________________________

Title: ___________________________

Date: ______________

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SECTION 1.0

INTRODUCTION

This Sitewide Safety and Health Plan (SSHP) has been developed by ERM-West, Inc., (ERM) to establish the safety and health procedures required to minimize potential hazards to personnel who will be involved in soil and groundwater investigation, monitoring, and remediation activities planned for the Seattle Air National Guard Station (ANGS) located in Seattle, Washington. The provisions of this SSHP directly apply to ERM personnel and contractors, if utilized, who will be potentially exposed to safety and/or health hazards related to the project. This SSHP does not directly apply to client personnel, although ERM will advise the client on the safety and health aspects of the work based upon the guidelines specified in this SSHP.

The procedures in this SSHP have been developed based upon current knowledge regarding the specific chemical and physical hazards that are known or anticipated for the operations to be conducted at the Base. This SSHP has been written to comply with the requirements of ERM safety and health policies. It is ERM's policy that activities covered by this SSHP must be conducted in complete compliance with this SSHP and with all applicable federal, state, and local safety and health regulations, including the Federal/Occupational Safety and Health Administration (OSHA) Construction Industry Standards in 29 Code of Federal Regulations (CFR) 1910.120 On-site personnel who cannot, or will not, comply with these requirements will be excluded from project activities. Prior to the commencement of field activities, all ERM and subcontractor personnel covered by this SSHP must review this document and return the sign-off form to the Project Manager.

1.1 Site Description and History

This section discusses the general history and physiography of the Seattle ANGS in Seattle, Washington. Site location and land use are described, hazardous chemicals associated with site activities and known releases are identified, and general site characteristics are presented.

1.1.1 Location

The Seattle ANGS is located in the northwest corner of King County International Airport (KCIA), Seattle, King County, Washington. The Seattle ANGS, which is the headquarters for the 143rd Combat Communications Squadron (CCSQ), is located at 6736 Ellis Avenue South and currently occupies 7.5 acres. The KCIA is located approximately 3 miles south of the Seattle central business district. Land use in the vicinity of the Seattle ANGS is primarily industrial and commercial.

1.1.2 Operations History

Seattle ANGS was built during World War II by the War Department and was used by the Army Air Force as the "Aircraft Factory School" during the war. In 1948, the property was transferred to King County as surplus property and was subsequently leased to the WANG.

On 21 April 1948, the 143rd Aircraft Control and Warning Squadron was established. From May 1951 to February 1953, the 143rd was activated for recruitment purposes. During this period of time, the unit has two C-47 aircraft. In 1960, the name of the unit was formally changed to the 143rd communication Squadron Tributary Teams. In 1969 and 1988, the name of the unit was again changed, becoming the 143rd Mobile Communications Squadron and the 143rd CCSQ, respectively. The current mission of the 143rd CCSQ is to provide mobile communications support and telephone/teletype support for airports and airfields.

In 1948, the Seattle ANGS consisted of 17 acres of land, including an aircraft parking ramp, leased from King County. At that time, the property contained 15 buildings (including a number of small shed structures), all of which were subsequently demolished. In 1951, a new property lease decreased the size of the ANGS from 17 acres to its present size of 7.5 acres, and buildings were constructed for headquarters, mess hall, warehouse, and vehicle service requirements. In 1980, the National Guard Bureau and Congress funded $2.3 million for the replacement of all buildings at the Seattle ANGS. The buildings were completed in 1984, with the exception of the Mobility Warehouse, which was completed in 1988. Seattle ANGS now consists of 7.5 acres and four buildings with a total area of 34,698 square feet. The Seattle ANGS property is leased from King County by the U. S. Air Force, who in turn licenses the property to the Washington State Military Department for Air National Guard use.

The operations of the 143rd CCSQ include ground vehicle maintenance; electrical maintenance; and petroleum, oil, and lubricants (POL) distribution and management. Significant quantities of gasoline, diesel fuel, and engine oil are used on the Seattle ANGS, as are smaller amounts of industrial solvents, antifreeze, paints, and acids. Typical wastes include contaminated fuels, spent solvents, off-specification materials, and refrigeration oils.

1.2 Prior Investigations

A Preliminary Assessment/Site Inspection (PA/SI) was completed by Operational Technologies Corporation (OTC) between 1991 and 1995. OTC completed a geophysical survey, soil gas survey, and three soil borings, and installed a total of 3 piezometers in the Burial Site Area of Concern (AOC) at the Seattle ANGS. The geophysical survey was completed using ground-penetrating radar (GPR) and magnetometer methods to detect possible buried waste materials or containers in the AOC.

Beryllium and TPH were detected at concentrations greater than the appropriate Model Toxics Control Act (MTCA) cleanup levels in soil samples collected by OTC from the soil borings at the Burial Site AOC. Beryllium was detected at a maximum concentration of 1.1 milligrams per kilogram (mg/kg). TPH was detected at a maximum concentration of 780 mg/kg in soil samples collected by OTC from the soil borings at the Burial Site AOC. Gross alpha and gross beta analyses for soil samples collected from the soil borings at the Burial Site AOC by OTC indicate particle activity from 0 to 4 picoCuries per gram (pC/g).

Arsenic, beryllium, chromium, and lead were detected at concentrations greater than the appropriate MTCA cleanup levels in groundwater samples collected by OTC from the piezometers at the Burial Site AOC. The maximum concentrations detected in the groundwater samples are as follows: arsenic - 28 micrograms per liter (μg/l), beryllium - 820 μg/l, chromium - 97 μg/l, and lead - 26 μg/l. Gross alpha and gross beta analyses for groundwater samples collected from the piezometers at the Burial Site AOC by OTC indicate particle activity from 15 to 77 picoCuries per liter (pC/l). The MTCA cleanup level for gross alpha activity is 15.0 pC/l.

1.3 Investigation Work Plan

The investigation work plan is entitled *Installation Restoration Program (IRP) Final Remedial Investigation/Feasibility Study Work Plan* (ERM, July 1996).

SECTION 2.0

KEY PERSONNEL

The organization and responsibilities for implementing safe project activities, and more specifically the requirements contained in this SSHP, are discussed in this section.

The key personnel for this project are:

• Project/Site Manager	Robin G. Weesner, R.G.
• Geologist/Field Personnel	To be assigned
• Site Safety and Health Officer	To be assigned
• Director, Internal Safety and Health	Steven Meyers, CIH

2.1 Project/Site Manager

The ERM Project/Site Manager is, by designation, the individual who has the primary responsibility for ensuring the overall safety and health of this project. The Project/Site Manager, therefore, has the primary responsibility for ensuring the implementation of the requirements of this SSHP. The Project/Site Manager's specific responsibilities include:

- Ensuring that all project personnel have received a copy of and have read this SSHP and have completed the SSHP signature sheet;
- Requiring the attendance of all site personnel to a tailgate briefing apprising them of the contents of this SSHP and specific hazards identified to be present at the facility prior to performing work;
- Ensuring that sufficient personal protective equipment (PPE), as required by this SSHP, is available during the project;
- Obtaining all subcontractor documentation of employee participation in a medical monitoring and training program;
- Maintaining a high level of safety and health consciousness among employees at the facility; and

- Maintaining regular communications with the site Safety and Health Officer (SHO) and, if necessary to resolve safety and health conflicts, the Director, Internal Safety and Health (DISH).

2.2 Site Safety and Health Officer (SHO)

The appointed SHO will be a member of the ERM project field team. The SHO responsibilities include enforcing the requirements of this SSHP once work begins. By design, the SHO has the authority to immediately correct all situations where noncompliance with this SSHP is noted and to immediately stop work in cases where an immediate danger is perceived. The SHO's specific responsibilities include:

- Procuring and distributing the PPE and air monitoring instrumentation needed for the project;
- Verifying that all PPE and safety and health equipment is in good working order;
- Setting up and maintaining the personnel decontamination facility;
- Controlling site entry of unauthorized personnel;
- Supervising and monitoring the safety performance of all personnel to ensure that required safety and health procedures are followed, and correcting any deficiencies;
- Conducting accident/incident investigations and preparing investigation reports; and
- Initiating emergency response procedures.

2.3 Director, Internal Safety and Health (DISH)

ERM's DISH is the individual responsible for the preparation, interpretation, and modification of this SSHP. Modifications to this SSHP which may result in less stringent precautions cannot be undertaken by the Project/Site Manager or the SHO without the approval of the DISH. Specific responsibilities of the DISH include:

- Advising the Project/Site Manager and SHO on matters relating to safety and health on this project;

- Recommending appropriate PPE and air monitoring instrumentation to protect personnel from potential hazards present on site;
- Performing field audits, when necessary, to monitor the effectiveness of the SSHP and to ensure compliance with it;
- Conducting or directing personal exposure monitoring where required and where deemed necessary to determine the adequacy of protective measures and PPE specified by this SSHP;
- Maintaining contact with the Project/Site Manager to regularly evaluate project conditions and new information which might require modification to this SSHP;
- Working with the Project/Site Manager to ensure that sufficient PPE is available at the site; and
- Conducting briefing meetings, when necessary, to apprise personnel of the contents of this SSHP and the project hazards.

2.4 Field Personnel

All field and subcontractor personnel are responsible for following the safety and health procedures specified in this SSHP and for performing their work in a safe and responsible manner. Specific requirements include:

- Obtaining a copy of this SSHP and reading it, in its entirety, prior to the start of field activities;
- Signing the Safety and Health Signature Sheet acknowledging receipt and understanding of this SSHP;
- Bringing forth any questions or concerns regarding the content of the SSHP to the SHO, Project/Site Manager, or DISH prior to the start of work;
- Reporting accidents/incidents and the presence of potentially hazardous working situations to the SHO and Project/Site Manager; and
- Complying with the requests of the appointed SHO.

SECTION 3.0

PARTICIPANT QUALIFICATIONS

3.1 Training Requirements

All ERM personnel working on the Seattle ANGS soil and groundwater investigation, monitoring, and remediation activities will have completed an extensive training course and have previously worked at least 3 days at a hazardous waste site. The training course must be designed to meet the requirements of 29 CFR 1920.120. The training course must consist of a combination of 40 hours of classroom and field exercises plus an annual 8-hour refresher.

All site participants will be required to show proof of current training (less than 1 year since initial or refresher training) prior to field activities. Intended participants without current training documentation will be barred from site activities.

3.2 Medical Surveillance

All on-site personnel, subcontractors, and visitors will be required to have a written statement from a licensed physician stating they have had a medical examination which meets the requirements of 29 CFR 1910.120. This examination must include pulmonary function testing as well as certification by the physician of the employee's ability to wear a negative-pressure respirator and perform strenuous work. If a person sustains an injury or contracts an illness related to work on site that results in lost work time, he/she must obtain written approval from a physician to regain access to the site.

3.3 Record Keeping

Air monitoring via industrial hygiene monitoring or direct reading instrumentation will become part of the written record. Both medical and air monitoring data will be retained for 30 years. Training records shall be maintained in project files and are available for inspection at any time. Subcontractor training and medical surveillance certification will also be maintained in project files.

SECTION 4.0

HAZARD EVALUATION

4.1 Chemical Hazards

Based on previous data collected from soil and ground water beneath the site and adjacent areas, the suspected chemical hazards of concern at the Seattle ANGS are TPH, metals (arsenic, beryllium, chromium, and lead), and gross alpha and gross beta particle activity. These materials may exist in the soil and/or groundwater.

4.1.1 Hydrocarbons

Most organic compounds, except those known to be carcinogenic, exhibit similar hazard effects in humans. Effects on the central nervous and upper respiratory systems as well as skin irritation predominate. Therefore, although a summary of the hazards of the identified hydrocarbons are listed separately below, additive effects of the mixture will be taken into consideration when determining established action levels.

Benzene. Benzene is a known human carcinogen that can cause leukemia via chronic exposure. It is a severe eye and moderate skin irritant. Human effects by inhalation and ingestion include: euphoria, changes in sleep and motor activity, nausea and vomiting, other blood effects, dermatitis and fever. In industry, inhalation is the primary route of chronic benzene poisoning. Poisoning by skin contact has also been reported. Although the current Fed/OSHA PEL for benzene is 1 ppm, recent research (1987) indicates that effects are seen at less than 1 ppm over extended periods.

Diesel. Diesel is a mix of hydrocarbons, chiefly of the methane series having 10 to 16 carbon atoms per molecule. It is a severe skin irritant with systemic effects by ingestion. It is combustible when exposed to heat or flame and can react with oxidizing materials. The vapor is also moderately explosive when exposed to heat or flame.

Ethylbenzene. Ethylbenzene is mildly toxic by inhalation and skin contact. Inhalation can cause eye, sleep and pulmonary changes. It is an eye and skin irritant at levels as low as 0.1% (1,000 ppm) of the vapor in air. At higher concentrations, it is extremely irritating at first, then can cause dizziness, irritation of the nose and throat, and a sense of constriction in the chest. The current Fed/OSHA PEL is listed as 100 ppm.

Gasoline. Gasoline varies in composition, but, in general, consists of hexanes, heptanes, octanes, and aromatic hydrocarbons. Exposure to gasoline and other petroleum hydrocarbons can produce narcotic effects such as dizziness, headaches, and giddiness similar to alcohol intoxication. Gasoline is also an irritant to the mucous membranes and can irritate the eyes, throat, and skin. The Cal/OSHA PEL for gasoline is 300 ppm. The short term exposure limit (STEL) for 15 minutes is 500 ppm. Most people can detect gasoline vapor in concentrations as low as 50 ppm via their sense of smell. Exposed skin should be washed promptly with soap and water, and eyes should be flushed immediately with eyewash solution for a minimum of 15 minutes. Ingestion warrants immediate medical attention.

Heavy Waste Oils. Heavy waste oils, including lubricants, grease, and used motor and hydraulic fluids, have been shown to cause skin cancer during prolonged dermal exposure in laboratory animals. Therefore, dermal protection must be provided when contact with used oil is suspected. Contaminated skin should be washed as soon as possible.

Toluene. Human systemic effects of exposure to toluene include: central nervous system changes, hallucinations or distorted perceptions, motor activity changes, psychophysiological changes and bone marrow changes. It is a severe eye irritant and an experimental teratogen. The current Fed/OSHA PEL for toluene is listed as 200 ppm.

Xylene. Xylene exhibits the general chlorinated hydrocarbon central nervous system effects and olfactory (smell) changes, eye irritation and pulmonary changes. It is a severe skin irritant. Irritation can start at 200 ppm. The current Fed/OSHA PEL is listed as 100 ppm for all three isomers (ortho, meta, and para).

Table 4-1 is a summary of identified compounds and their associated exposure information.

4.1.2 Metals

Human physiological effects to metals varies with the compound. An overview of common hazardous metals follows.

TABLE 4-1
Potential Site Compounds and Associated Exposure Information

Compound	OSHA Permissible Exposure Level (PEL)	Source Characteristic	Route of Exposure	Symptoms of Exposure	Monitoring Instrument
Total Petroleum Hydrocarbons (TPH)-Gasoline	None	Clear to amber liquid with an aromatic odor	Inh, Ing, Con	CNS depression, eye, nose, and throat irritation	PID/FID
Benzene	1 ppm	Colorless liquid with an aromatic odor	Inh, Abs, Ing, Con	Skin, eye, nose, & throat irritation; dermatitis	PID/FID
Ethylbenzene	100 ppm	Colorless liquid, chloroform-like odor	Inh, Ing, Con	CNS depression, eye, nose, and throat irritation	PID/FID
Toluene	200 ppm	Colorless liquid with a sweet, pungent, benzene-like odor	Inh, Abs, Ing, Con	CNS depression, dilated pupils, nervousness, fatigue	PID/FID
Xylenes	100 ppm	Colorless liquid with an aromatic	Inh, Abs, Ing, Con	CNS depression; skin,eye, nose, and throat irritation, nausea, vomiting	PID/FID
TPH as Diesel	None	Red-amber liquid, fuel odor	Inh, Ing, Con	CNS depression, eye irritation	PID/FID
TPH as Heavy Waste Oils	None	Dark brown or black liquid, petroleum odor	Ing, Con	Skin irritation, poss. carcinogens	PID/FID, Visual

TABLE 4-1

Potential Site Compounds and Associated Exposure Information

Compound	OSHA Permissible Exposure Level (PEL)	Source Characteristic	Route of Exposure	Symptoms of Exposure	Monitoring Instrument
Arsenic	10 µg/M^3	Siver-gray or tin white metal, brittle, odorless	Inh, Abs, Ing, Con	Aching eyes, blurred vision, respiratory constriction, cyanosis, nausea, vomiting, CNS depression	Visual
Beryllium	2 µg/M^3	Hard, brittle, gray-white metal	Inh	Respiratory symptoms, weakness, fatigue, carcinogenic	Visual
Chromium	0.05 µg/M^3 (hexavalent) 0.5 µg/M^3 (trivalent) 1 µg/M^3 (metallic)	Blue-white to steel gray, lustrous, hard metal	Inh, Ing, Con	Respiratory irritation, skin irritation, liver & kidney damage, carcinigenic (hexavalent compounds)	Visual
Lead	50 µg/M^3	Heavy, ductile, soft, gray metal	Inh, Ing, Con	Weakness, insomnia, facial pallor, abdominal pain, eye iritant	Visual

ppm = Parts per million
µg/M^3 = Micrograms per cubic meter
Inh = Inhalation
Ing = Ingestion
Con = Contact
Abs = Absorption
PID = Photoionization detector
FID = Flame ionization detector

Arsenic. Arsenic is a naturally-occurring gray metal-like element which is normally found in the environment combined with other elements such as oxygen, chlorine, and sulfur (inorganic arsenic). Organic forms of arsenic are usually less harmful than inorganic forms. Inorganic arsenic has no smell nor taste. Health effects via ingestion include irritation of the stomach and intestines, pain, nausea, vomiting and diarrhea. Blood cell changes, blood vessel damage and impaired nerve function can also result from chronic arsenic ingestion. Other effects include skin changes, irritation of the throat, increased risk of cancer of the liver, bladder, kidney, and lung. The current Fed/OSHA PELs are listed as 10 $\mu g/M^3$ for inorganic forms of arsenic and 0.5 mg/M^3 for organic forms.

Beryllium. Beryllium is a confirmed carcinogen with experimental carcinogenic, neoplastigenic, and teratogenic data. Human systemic effects by inhalation include lung fibrosis, dyspnea, and weight loss. The current Fed/OSHA PEL for beryllium is listed as 2 $\mu g/M^3$.

Chromium. Chromic acid and its salts have a corrosive action on the skin and mucous membranes. The lesions are confined to the exposed parts, affecting chiefly the skin of the hands and forearms and the mucous membranes of the nasal septum. Chromate salts are human and experimental carcinogens of the lungs, nasal cavity and paranasal sinus, and are also experimental carcinogens of the stomach and larynx. Hexavalent compounds are more toxic than trivalent. The current Fed/OSHA PEL for chromium compounds is listed as 0.05 mg/M^3, 0.5 mg/M^3, and 1 mg/M^3 for hexavalent, trivalent, and metal compounds, respectively.

Lead. Considerable data exists on the effects of lead exposure in humans. It is a poison by ingestion and a suspected human carcinogen of the lungs and kidneys. There are data to suggest that lead is a mutagen and can cause reproductive effects. Human systemic effects by ingestion and inhalation (the two routes of absorption) include: loss of appetite, anemia, malaise, insomnia, headache, irritability, muscle and joint pains, tremors, flaccid paralysis without anesthesia, hallucinations and distorted perceptions, muscle weakness, gastritis, and liver changes.

Recent experimental evidence suggests that blood levels of lead below 10 $\mu g/dl$ (micrograms per deciliter) can have the effect of diminishing the IQ scores of children. The current Fed/OSHA PEL is listed as 50$\mu g/M^3$ as an 8-hour time weighed average (TWA). OSHA also requires follow-up medical monitoring for all employees whose blood lead levels are at or above 40 $\mu g/dl$.

4.1.3 Radiological Hazards

Electromagnetic radiation (also called radiant energy) is emitted from matter in the form of photons, each having an associated electromagnetic wave having frequency and wavelength. The various forms of radiant energy are characterized by their wavelength, and together they comprise the electromagnetic spectrum, the components of which are as follows: 1) cosmic gamma rays, 2) gamma rays from radioactive disintegration of atomic nuclei, 3) x-rays, 4) ultraviolet rays, 5) visible light rays, 6) infrared, 7) microwave, and 8) radio and electric rays. Radiation having the shortest wavelength is the most penetrating. Photons are not electrically charged and have no mass, their velocity is the same, and all display the properties characteristic of light.

Ionizing radiation consists of extremely short-wavelength, highly energetic, penetrating rays of the following types: a) gamma rays emitted by radioactive elements and radioisotopes (decay of atomic nucleus); b) x-rays generated by sudden stoppage of fast-moving electrons; c) subatomic charged particles (electrons, protons, deuterons) when accelerated. Ionizing radiation is considered electromagnetic radiation at least as energetic as x-rays and charged particles of similar energies. Neutrons also may induce ionization. Such radiation is strong enough to remove electrons from any atom in its path, leading to the formation of free radicals.

Ionizing radiation are short-lived but highly reactive particles that initiate decomposition of many organic compounds. Thus, ionizing radiation can cause mutations to DNA and in cell nuclei; adversely affect protein and amino acid mechanisms; impair or destroy body tissue; and attack bone marrow, the source of red blood cells. Exposure to ionizing radiation for short periods is highly dangerous, and for an extended period may be lethal.

4.2 Physical Hazards

Physical hazards associated with site activities include slips, trips, falls, contact and crushing type injuries, eye abrasions, contusions, lacerations, flammability, and heat stress concerns. The potential for such hazards necessitates the use of gloves, safety shoes or boots, eye goggles or glasses and hard hats. Additionally, personnel engaged in strenuous physical labor are to wear sturdy work gloves.

4.2.1 Use of Equipment

Any equipment, including vehicles, winches or other machinery will be operated in strict compliance with the manufacturer's instructions, specifications, and limitations as well as any applicable regulations. The operator is responsible for inspecting the equipment daily to ensure that it is functioning properly and safely. This inspection will include all pins, pulleys, and connections subject to faster than normal wear and all lubrication points.

When equipment with moving booms, arms, or masts are operated in the vicinity of overhead hazards, the operator, with assistance from the designated signaling person, will ensure that the moving parts of the equipment maintain safe clearances to the hazards. Equipment will be kept at least 20 feet away from energized electrical lines.

All portable equipment and tools will be inspected prior to each day's use and as often as necessary to ensure that it is safe to use. Defective equipment and tools will be removed from service immediately. Examples of defective tools include: hooks and chains stretched beyond allowable deformations, cables and ropes with more than the allowable number of broken strands, missing grounding prongs on power tools, defective on/off switches, mushroomed heads of impact tools, sprung wrench jaws, missing or broken handles or guards as well as wooden handles which are cracked, splintered, or loose. All equipment and tools will be used within their rated capacities and capabilities.

4.2.2 Flammability Hazards

Due to the nature of this project, the hazards associated with flammability are expected to be low. However, the following good management practices shall apply at the site.

All electrical equipment used during the project will be inspected to ensure that it is in good repair and has no frayed or loose connections before use on site. Only approved, listed equipment and components will be used. All connections will be made in accordance with National Electric Code practices. All equipment and devices so designed will be properly grounded or bonded to an adequate grounding mechanism. Although explosive limits are not expected, only equipment listed as explosion proof will be used in areas where explosivity is sustained at or above 5 percent of the LEL.

4.2.3 Heat Stress Concerns

Heat stress is the combination of both environmental and physical work factors that contribute to the total heat load imposed on the body. Environmental factors that contribute to heat stress include air temperature, radiant heat exchange, air movement, and humidity.

The body's response to heat stress is reflected in the degree of symptoms. When the stress is excessive for the exposed individual, a feeling of discomfort or distress may result and a heat-related disorder may ensue. The severity of the response will depend not only on the magnitude of the prevailing stress, but also on the age, physical fitness, degree of acclimatization, and dehydration of the worker.

Heat stress is a general term used to describe one or more of the following heat-related disabilities and illnesses.

Heat Cramps. Painful, intermittent spasms of the voluntary muscles following hard physical work in a hot environment. Cramps usually occur after heavy sweating and often begin at the end of a work shift.

Heat Exhaustion. Profuse sweating, weakness, rapid pulse, dizziness, nausea, and headache. The skin is cool and sometimes pale and clammy with sweat. Body temperature is normal or subnormal. Nausea, vomiting, and unconsciousness may occur.

Heat Stroke. Sweating is diminished or absent. The skin is hot, dry, and flushed. Increased body temperature, if uncontrolled, may lead to delirium, convulsions, coma, and even death. Medical attention is needed immediately.

Workers will be trained on the signs and symptoms of the forms of heat stress and will be encouraged to monitor themselves and others. In addition, experience has shown that the following work/rest regimen is appropriate for field workers performing various degrees of work while wearing Level D (no protective clothing). All values are given in °C Wet Bulb Globe Temperature (WBGT):

Work/Rest Regimen	Work Load		
	Light	Moderate	Heavy
Continuous Work	30.0	26.7	25.0
75% work/25% rest each hour	30.6	28.0	25.9
50% work/50% rest each hour	31.4	29.4	27.9
25% work/75% rest each hour	32.2	31.1	30.0

WBGT is defined according to the following formula (outdoors with solar load) where WB, GT, and DB are the wet bulb, globe, and dry bulb temperatures, respectively:

$$WBGT = 0.7WB + 0.2GT + 0.1DB$$

The workload classes are defined in The American Conference of Governmental Industrial Hygienists booklet, "Threshold Limit Values and Biological Exposure Indices for 1995-1996."

4.2.4 Cold Stress

Fatal exposures to cold among workers have almost always resulted from accidental exposures involving failure to escape from low environmental air temperatures or from immersion in low temperature water. Cold stress (hypothermia) and cold injury can be avoided by preventing a fall in the deep core temperature of the body.

Symptoms of hypothermia include increases in metabolic rate in an attempt to compensate for the heat loss and shivering. Workers should be protected from exposure to cold so that the deep core temperature does not fall below 36° C (96.8° F). Lower body temperatures can result in reduced mental alertness, reduction in rational decision making, or loss of consciousness with the threat of fatal consequences.

Pain in the extremities may be the first early warning of danger to cold stress. During exposure to cold, maximum severe shivering develops when the body's temperature has fallen to 35° C (95° F). **Exposure to cold shall be immediately terminated for any worker when severe shivering becomes evident.**

The body must be protected from exposure to cold air temperatures via whole body protection:

- Adequate insulating clothing must be provided to workers if work is performed in air temperatures below 40° F.
- Older workers or workers with circulatory problems must be provided with extra insulating clothing and/or a reduction in the duration of exposure.
- Gloves shall be used by all workers if the air temperature falls below 40 degrees F.

To prevent frostbite, workers should wear insulating gloves when contact with cold surfaces below 20° F are possible. Mittens are required if the air temperature falls below 0° F.

If insulating clothing is not adequate to prevent sensations of excessive cold or frostbite, auxiliary heaters or suspension of work is required.

SECTION 5.0

EXPOSURE MONITORING PLAN

5.1 Area and Personal Monitoring

Air monitoring will be conducted to determine the presence of on-site hazardous conditions and will help determine the level of personal protection required for personnel. Environmental monitoring equipment will include a photoionization detector (PID) or a flame ionization detector (FID). Characterization with these instruments will determine airborne contaminants present and their concentrations in the workplace and will help assess worker safety.

5.1.1 General Area Monitoring

Area air monitoring will be conducted during all field work. The intent is to utilize generic field instruments and action levels to assess the continuous exposure to field personnel during the investigation and upgrade or downgrade PPE in response to the monitoring. The general monitoring shall consist of daily breathing zone monitoring every 15 minutes using the PID or FID. In addition, upon unlocking each monitoring well, the well headspace will be monitored using a PID or FID. Daily calibration and maintenance of the PID or FID will also be recorded and performed according to the manufacturer's recommendations (see Appendix A for calibration documentation sheet). All breathing zone readings will be recorded in the field log book.

5.2 Action Levels

The SHO will establish daily background total organic vapor (TOV) levels prior to initiating site activities. Under most circumstances, this level can be determined by taking multiple readings at representative locations along the perimeter of the site and averaging the results of sustained measurements.

Decisions to upgrade or downgrade personal protection will be based on sustained breathing zone TOV levels that exceed background levels. Breathing zone refers to the area from the top of the shoulders to the top of the head. Specific criteria for upgrading or downgrading personal protection based on TOV levels is presented in the following table.

Sustained Breathing Zone TOV	**Level of Protection**
Background + 5 ppm	**Level-D** (no respiratory protection)
5 ppm to 20 ppm	**Level-C** [half face air purifying respiratory equipped with organic vapor/High Efficiency Particulate Air (HEPA) cartridges]
20 ppm to 50 ppm	**Level-C** (full face air purifying respirators equipped with organic vapor/HEPA cartridges)
Above 50 ppm	**Level-B** (supplied air respirators)

SECTION 6.0

GENERAL SAFE WORK PROCEDURES

6.1 Personal Protection

In addition to the respiratory protection described above, initial protection shall also include Tyvek, hard hats, eye protection, inner latex or PVC gloves, outer nitrile gloves, and safety boots. It is expected that the highest level of protection which may be needed during field investigation activities will be Level C. Level C protection consists of the following:

- Level D protection which consists of:
    - Full length shirt and long pants;
    - Steel toed boots or safety shoes;
    - Safety glasses; and
    - Hard hat.
- Air-purifying respirator equipped with appropriate filter cartridges;
- Chemical resistant clothing (i.e., Tyvek, poly-coated Tyvek or Saranax Suits). Suits are to be one-piece with attached hoods and elastic wrist bands;
- Outer chemical resistant gloves and inner latex surgical gloves; and
- Chemical resistant overboots.

6.2 Work Zones and Decontamination Procedures

Work zones and decontamination procedures will be established in accordance with guidance provided in Chapters 9 and 10 of the NIOSH/OSHA/USCG/EPA document *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities.* Where applicable, the exclusion zones will be marked with yellow caution tape. The location of the zones may be modified to fit applicable field conditions; however, proposed modifications must be approved by the HSO.

If necessary, a minimum two basin wash/rinse station will be placed in the contamination/reduction zone to facilitate cleaning and removal of PPE. The two wash/rinse stations will be used by workers to clean and rinse boots and gloves. The ground beneath these basins will be covered with plastic to ensure the ground is not contaminated with basin rinse water. A drum or other container will be designated to dispose of PPE that will not be reused.

It is expected that the highest level of protection used during project investigation activities will be Level C. Based on the level of expected exposure to chemical constituents, the following decontamination protocol will be used:

- Station 1: Equipment Drop - Deposit equipment used on site (e.g., tools, sampling devices and containers, monitoring instruments, radios, and clipboards) on plastic drop cloths. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool down station may be set up within this area.

- Station 2: Outer Garment, Boots, and Gloves Wash and Rinse - Scrub outer boots and gloves, and splash suit with decon solution or detergent water. Rinse off using copious amounts of water.

- Station 3: Outer Boot and Glove Removal - Remove outer boots and gloves. Deposit in container with plastic liner.

- Station 4: Canister or Mask Change - If worker leaves exclusion zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot covers are donned, joints are taped, and worker returns to duty.

- Station 5: Boots, Gloves, and Outer Garment Removal - Boots, chemical-resistant splash suit, and inner gloves are removed and deposited in separate containers lined with plastic.

- Station 6: Face Piece Removal - Face piece is removed. Avoid touching face with fingers. Face piece is deposited on plastic sheet.

- Station 7: Field Wash - Hands and face are thoroughly washed. Shower if body contamination is suspected.

All personnel must follow the appropriate order for cleansing and removal during decontamination: boots, outer gloves, coveralls or protective suit, respirators, and inner gloves. Direct contact with contaminated PPE can be avoided by a proper decontamination sequence. Respirators, if used, are not to be removed before leaving the contaminated area to avoid a potential inhalation hazard during decontamination.

Water, soap, and paper towels will be available for cleaning of hands and face before breaks, eating, drinking, or smoking. On-site toilet facilities will also be available.

6.3 General Safety Rules

In addition to the specific requirements of this SSHP, common sense should prevail at all times. The following general safety rules and practices will be in effect at the site.

- The site will be suitably marked or barricaded as necessary to prevent unauthorized visitors, but will not hinder emergency services, if needed.

- All open holes, excavations, trenches, and obstacles will be properly barricaded in accordance with local site needs. These needs will be determined by proximity to traffic ways, both pedestrian and vehicular, and site of the hole, trench, or obstacle. If holes are required to be left open during nonworking hours, they will be adequately decked over or barricaded and sufficiently lighted.

- Prior to conducting any digging or boring operations, underground utility locations will be identified. The site representative and local utility authorities (or Underground Alert) will be contacted to provide locations of underground utility lines and product piping. All boring, excavation, and other site work will be planned and performed with consideration for underground lines.

- Smoking and ignition sources in the vicinity of flammable or contaminated material is prohibited. Designated smoking areas will be delineated.

- Drilling, boring, movement and use of cranes and drilling rigs, erection of towers, movement of vehicles, and equipment as well as other activities will be planned and performed with consideration for the location, height, and relative position of aboveground utilities and fixtures, including signs, lights, canopies, buildings, other structures, and construction as well as natural features such as trees, boulders, bodies of water, and terrain.

- When working in areas where flammable vapors may be present, particular care must be exercised with tools and equipment that may be sources of ignition. All tools and equipment so provided must be properly bonded and/or grounded.
- Individuals with beards that interfere with respirator fit are not allowed within the exclusion zone. This is necessary because all site personnel may be called upon to use respirator protection in some situations, and beards do not allow for proper respirator fit.
- No smoking, eating, or drinking will be allowed in the contaminated areas.
- Tools and hands must be kept away from the face.
- Personnel must shower at the end of the shift or as soon as possible after leaving the site.
- Each sample must be treated and handled as though it were extremely toxic.
- Do not touch obvious contaminated materials. Avoiding contact with these materials will facilitate decontamination.
- Persons with long hair and/or loose-fitting clothing that could become entangled in power equipment are not permitted in the work area.
- Horseplay is prohibited in the work area. The SHO has the authority to discharge site personnel for horseplay.
- Work while under the influence of intoxicants, narcotics, or controlled substances is prohibited.

Prior to the commencement of each day's activities, the HSO will conduct a daily tailgate safety meeting outlining new or potential hazards that may be encountered during site operations. The daily tailgate safety meetings will be documented by completion of the appropriate form located in the Attachment to this document.

SECTION 7.0

EMERGENCY RESPONSE/ACCIDENT INVESTIGATION

The phone numbers of the police and fire departments, ambulance services, local hospital, and ERM representatives are provided in the reference sheet at the back of this SSHP. Directions to the hospital are also provided on the sheet.

In the event of a health or safety emergency at the site, appropriate emergency measures will immediately be taken to assist those who have been injured or exposed and to protect others from hazards. The HSO will be immediately notified and will respond according to the seriousness of the injury. Personnel trained in first aid will be present during site activities to provide appropriate treatment of injuries or illnesses incurred during operations. The ERM Project/Site Manager will be immediately informed of any serious injuries.

Any accident/incident resulting in an OSHA recordable injury or illness, treatment at a hospital or physician's office, property damage or a near miss accident requires that an accident/incident report be completed and submitted to the ERM DISH. The investigation will be initiated as soon as emergency conditions are under control. The purpose of this investigation is not to attribute blame but to determine the pertinent facts so that repeat or similar occurrences can be avoided.

7.1 Planning

Prior to facility entrance, the SHO shall plan emergency actions and discuss them with personnel conducting project work. Initial planning includes establishing the best means for evacuation from the area in case of a catastrophe.

7.2 Emergency Services

A tested system must exist for rapid and clear distress communications, preferably voice, from all personnel to the SHO. The SHO shall ensure that all personnel working at the facility know how to communicate with the appropriate local emergency response units as well as provide adequate and clear directions between work locations and the locations of support personnel, prior to commencing any facility investigation or operations. Emergency response contacts and telephone numbers are included in the emergency reference sheet. A copy of this information must be posted in a visible location at the project site before operations commence.

7.3 General Evacuation Plan

In case of fire, explosion, or toxic vapor release and a site evacuation is ordered by the SHO:

- Announce the evacuation via radio/horn;
- Evaluate the immediate situation and downwind direction. All personnel will evacuate in the upwind direction;
- All personnel will assemble in an upwind area when the situation permits and a head count will be taken by the SHO; and
- Determine the extent of the problem and dispatch response teams in protective clothing and self-contained breathing apparatus on-site to evaluate any missing personnel and correct the problem.

7.4 First Aid

Qualified personnel on site shall give first aid and stabilize any worker needing assistance. Life support techniques such as cardiopulmonary resuscitation and treatment of life-threatening problems such as bleeding, airway maintenance, and shock shall be given top priority. Professional medical assistance shall be obtained at the earliest possible opportunity. If assistance beyond first aid is required, phone 911, and request emergency medical assistance.

A first aid kit and emergency 16-oz eye wash station shall be maintained readily accessible to all workers. The portable eyewash shall be supplemented by a nearby continuous-flowing eyewash facility. Prior arrangements must be made to facilitate easy access (preferably within 10 seconds of the work area) to this continuous-flowing device.

Emergency first aid for organic compounds follows below.

7.4.1 Eyes

Flush eyes immediately with fresh water for at least 15 minutes while holding the eyelids open. If injury occurs or irritation persists, transport person to emergency room as soon as possible.

7.4.2 Skin

Wash skin thoroughly with soap and water. See a doctor if any unusual signs or symptoms or skin irritation occurs. Launder chemically-impacted clothing.

7.4.3 Inhalation

Move exposed person to fresh air. If breathing has stopped, apply artificial respiration. Call 911 immediately.

7.4.4 Ingestion

If swallowed, DO NOT make person vomit. Call Poison Control Center immediately.

7.5 Fire Protection and Response

To ensure that fire and explosion hazards are minimized, plans and procedures must be coordinated with the local Fire Department. A permit may be required before gasoline or other flammable liquids may be removed. Call 911 in the event of any fire at a work location. A minimum of one fire extinguisher with a minimum class rating of 20BC shall be provided within 50 feet of site activities.

7.6 Site Control Measures

The site control measures listed below are to be followed to minimize the potential contamination of workers, protect the public form potential site hazards, and control site access.

Barricades and barricade tape will be used to delineate an exclusion zone around drilling areas. An opening in the barricades upwind of the equipment will serve as an entry and exit point. A personnel decontamination station will be established at this point. All access to the drilling location will be made at the entry and exit point.

The site will be barricaded or otherwise made secure at the end of each workday. Soils will be placed on plastic and covered. Decontamination fluids will be drummed and properly labeled.

The SHO will log all site visitors in the field notebook and will ensure that all personnel entering the work zone are briefed on site activities and potential hazards.

7.7 Site Operation Zones

The following three Site Operation Zones will be established at each investigation site:

- Exclusion zone;
- Contamination reduction zone; and
- Support zone.

The exclusion zone includes areas of active investigation or cleanup. Prescribed levels of protection must be worn by all personnel within the exclusion zone. The boundary of the exclusion zone should be a well defined physical or geographical barrier.

The contamination reduction zone serves to prevent the transfer of hazardous materials picked up on personnel or equipment in the exclusion zone.

The support zone is the outermost area and is considered a noncontaminated area. The field operations command post, first aid station, and any other investigation support activities are located in the support zone. Potentially contaminated equipment is not allowed in this area.

7.8 Emergency Operation Shutdown Procedures

In the event an extremely hazardous situation develops on site, the SHO may temporarily suspend operations until the situation is corrected or controlled. The SHO will have the authority to restart operations when the situation as been corrected and safe working conditions have been restored.

7.9 Spill or Hazardous Material Release

Spills or hazardous material releases resulting in human exposure or off-site environmental contamination are reported to the appropriate authorities by the SHO. Small spills are reported to the SHO and are taken care of per the chemical manufactures' recommended procedures.

7.10 Community Safety

Release or off-site migration off contaminates during field operations is unlikely. However, in the event of a significant release of contaminants during field work, the proper state and local authorities will be immediately notified. Appropriate actions will be taken to protect the public and control the contaminate release or migration.

ATTACHMENT

SAFETY AND HEALTH FORMS

The following signatures indicate that the Safety and Health Program has been read and accepted by ERM management and personnel as well as all contractors and subcontractors and their personnel.

NAME	TITLE	COMPANY	SIGNATURE	DATE

SUPERVISOR'S ACCIDENT/INCIDENT INVESTIGATION REPORT

Injured Employee:	Title:	
Date of Accident/Incident:	Dept.:	
Location:	Time on this Job:	
Engaged in what work when injured:		
Nature of accident/incident:		
How did accident/incident occur?		
What can be done to prevent recurrence of the accident?		
What has been done to prevent recurrence of the accident?		
Supervisor's Signature:	Dept.:	Date:
Reviewer's Signature:	Dept.:	Date:
NOTE: To be submitted to the Safety and Health Manager within 2 days of the accident/incident.		

ERM-WEST/ERM ENVIROCLEAN-WEST

DAILY TAILGATE SAFETY MEETING FORM

DATE:__________ TIME:____________ JOB NUMBER:____________
PROJECT NAME: ____________________________________
SPECIFIC LOCATION: ______________________________
TYPE OF WORK: __________________________________
CHEMICALS PRESENT: ______________________________

SAFETY TOPICS DISCUSSED

Protective Clothing/Equipment: ______________________________

Hazards of Chemicals Present: ______________________________

Physical Hazards: ______________________________

Emergency Procedures: ______________________________

Hospital/Clinic:__________ Phone: __________ Paramedics: _____
Hospital Address: ______________________________

Special Hazards: ______________________________

Other Topics: ______________________________

ATTENDEES

Name (printed)	Signature

Appendix B

APPENDIX B

RESULTS OF REGULATORY RECORDS REVIEW AND ENVIRONMENTAL DATA RESOURCES, INC. DATABASE REPORT

APPENDIX B

RESULTS OF REGULATORY RECORD REVIEW

Boeing Company - North Field

The Boeing Company operates the North Field, a large industrial complex east and southeast of the Seattle Air National Guard Station (Seattle ANGS). Within the complex, several areas of concern have been identified. These areas are discussed below, in general order of distance from Seattle ANGS.

Fire Training Center

A fire suppression training area was operated at North Boeing Field from the early 1960s until early 1992. The training area consisted of an earthen berm reservoir that was filled with water and petroleum product. The reservoir was ignited during training exercises. An adjacent catchment basin stored runoff from the bermed area between exercises. In several phases of the investigation during the 1980s and early 1990s, soil samples collected at the site yielded concentrations of jet fuel-range petroleum hydrocarbons, xylenes, and a specialized aviation hydraulic fluid (Skydrol) that exceeded the Model Toxics Control Act (MTCA) Method A cleanup levels or special screening level (Skydrol). Arsenic was detected in groundwater samples collected from monitoring wells at concentrations slightly above MTCA Method A cleanup levels; however, petroleum compounds were not detected above MTCA Method A cleanup levels in groundwater samples collected from the site [Landau Associates, Inc. (Landau), 1992a].

In May 1993, approximately 3,000 cubic yards of petroleum-impacted soils were excavated from the vicinity of the bermed area and catchment basin. A 3,000-gallon jet fuel underground storage tank (UST) was removed from the site during the remedial excavation activities. Confirmation soil sampling indicated that soils collected from the limits of the excavation yielded concentrations of petroleum hydrocarbons that were less than the MTCA Method A cleanup levels.

The excavated soils were disposed of at Roosevelt Regional Landfill in Klickitat County, Washington (Landau, 1993a).

Soils underlying the northern portion of the Fire Training Center consist of a thin (approximately 1 foot) veneer of sandy fill underlain by sandy silt to fine sand to at least 20 feet below ground surface (bgs). Under the southern portion of the Fire Training Center, silty sand to fine sand fill of variable thickness (up to 6 feet) overlies a layer of coal ash, clinkers, and brick fragments approximately 1.5 to 10 feet thick. Soils below the coal combustion residue consist of fine sand with a trace of gravel to a depth of at least 35 feet bgs (Landau, 1992b).

According to historic sources, a meander of the Duwamish River was filled at the location of the present Fire Training Center site. The river channel trended west and southwest of the present location of Seattle ANGs (Landau, 1992a).

Static groundwater measurements by Landau (Landau, 1992b) in July 1992, indicate that groundwater was encountered between approximately 5.5 and 6.6 feet bgs. Groundwater flow was to the southwest at a gradient of approximately 0.008 foot per foot (ft/ft).

Storm Drain System Polychlorinated Biphenyls (PCBs)

Thirty-six sediment samples collected from storm drain manholes, catchbasins, an oil-water separator, the North Boeing Field Lift Station, and the Georgetown Flume at North Boeing Field were collected by Landau (1993b) in June through September 1993. Polychlorinated biphenyl (PCB) concentrations in the sediment samples ranged from nondetect to 1,240 milligrams per kilogram (mg/kg). Thirty-one of the samples contained concentrations of PCBs greater than 1 mg/kg.

Sediment and standing water were removed from the storm drain system at the site in October 1992 by spraying high-pressure water into sections of the system and pumping out the sediment and waste water (Landau, 1993c). Residual concentrations of PCBs in wipe samples collected from the storm sewer system after cleaning were less than the federal PCB regulatory limits specified in 40 Code of Federal Regulations (CFR) 761 (10 μg per 100 cm^2).

Green Hornet Area

Seacor (1994a) completed groundwater monitoring and sampling in four monitoring wells near the location of three 12,000-gallon jet fuel USTs between January 1992 and January 1993. Groundwater samples collected from two of the monitoring wells at the site contained concentrations of petroleum hydrocarbons greater than the MTCA Method A groundwater cleanup level during quarterly groundwater monitoring events, and light nonaqueous phase liquid (LNAPL) was consistently observed in another monitoring well at the site.

The jet fuel USTs were decommissioned and removed in February 1993, and the four monitoring wells at the site were abandoned (Seacor, 1994a). Soil samples obtained from the limits of the resulting excavation contained concentrations of petroleum hydrocarbons greater than the MTCA Method A soil cleanup levels.

In September 1993, an estimated 1,250 cubic yards of petroleum-impacted soils were excavated from the site. The excavated soil was transported to the Roosevelt Regional Landfill in Klickitat County, Washington. Groundwater encountered in the excavation exhibited a petroleum sheen. Gasoline- and diesel-range hydrocarbons were detected in soil samples collected from the final remedial excavation limits at concentrations greater than the MTCA Method A cleanup levels.

Six monitoring wells were installed around the perimeter of the remedial excavation by Seacor in November 1993. Gasoline- and diesel-range hydrocarbons were detected at concentrations greater than the MTCA Method A cleanup levels in soil samples collected near the water table in two of the borings that were subsequently converted into monitoring wells. Gasoline-, diesel-, and motor oil-range hydrocarbons and xylenes were detected at concentrations greater than the MTCA Method A cleanup levels in groundwater samples collected from the two monitoring wells installed nearest the remaining petroleum-impacted soils. Gasoline-range hydrocarbons were detected at concentrations less than the MTCA Method A cleanup level in the monitoring well installed west (downgradient) of the former UST locations.

Seacor (1994b) concluded that existing borings and monitoring wells have adequately characterized the nature and extent of soil and groundwater impacts at the site. Remaining petroleum-impacted soils and groundwater are limited in extent.

Soils encountered in the Green Hornet Area were reported by Seacor (1994a,b) as sand to gravelly sand to a depth of approximately 5 feet bgs, silt to silty sand from approximately 5 to 7 feet bgs, and fine sand with scattered interbeds of silty sand from approximately 7 to 16.5 feet bgs, the maximum depth sampled.

Seacor (1994a) reported that static groundwater levels at the site generally ranged from approximately 4 to 8.5 feet bgs, with a seasonal fluctuation of 1 to 2 feet. Based on measurements in the initial four site monitoring wells, local groundwater flow direction was toward the east or west-southwest with a gradient ranging from 0.010 ft/ft to 0.031 ft/ft (1994a). The eastern flow direction is an anomaly that Seacor attributes to groundwater mounding in the vicinity of the former aboveground storage tank (AST) area. The area was filled to a level approximately 8 feet above the surrounding grade. Groundwater levels measured in December 1993 in the six recently installed monitoring wells indicate a groundwater flow direction to the west-southwest with a gradient of approximately 0.001 ft/ft.

F & G Facility

Eight, jet fuel USTs were decommissioned at the F & G Facility in May and June 1994. Petroleum-impacted soils were excavated from the site during UST decommissioning activities in 1994. The soils were disposed of at the Roosevelt Regional Landfill in Klickitat County, Washington (Seacor, 1994d). Seacor (1994c,d) reported that petroleum-impacted soils were identified in soil borings installed in the vicinity of the former USTs. A total of eight monitoring wells were monitored by Seacor up to 1994. Petroleum hydrocarbons were detected at a concentration of 1.9 mg/kg in a monitoring well adjacent to the USTs in October 1993; however, petroleum hydrocarbons were not detected during subsequent sampling of the monitoring well in January and April 1994. Groundwater samples collected from the remaining monitoring wells at the site did not contain detectable concentrations of petroleum-related compounds.

Soils at the site are generally fine to medium sand with scattered layers and lenses of silt to silty sand to depths of 11 feet bgs, the maximum depth of explorations at the site (Seacor, 1994c).

Seacor (1994c) reported that groundwater in the area of the F&G Facility occurs between approximately 5 and 7 feet bgs. Groundwater flows to the west with a gradient of approximately 0.003 foot per foot (ft/ft).

Building 3-354

Groundwater Technology, Inc. [(GTI), 1991] completed eight soil borings in the vicinity of Building 3-354 in October 1991 as part of a preconstruction environmental assessment. Soil samples collected from three of the soil borings yielded petroleum-hydrocarbon concentrations greater than the MTCA Method A cleanup levels. Groundwater was not sampled at the site.

Soils encountered during site activities included silty fine sand to sandy coarse gravel to the total depth explored of 7 feet bgs (GTI, 1991). Groundwater was observed seeping into one of the borings at 7 feet bgs.

Building 3-360/361/365

Ten soil borings and four monitoring wells were completed in the vicinity of these buildings in November 1991 as part of a preconstruction environmental assessment performed by Seacor (1992a). The buildings are located southeast of the intersection of Ellis Avenue South and South Willow Street.

Petroleum hydrocarbons were detected at concentrations greater than the MTCA Method A cleanup levels in groundwater samples collected from two of the monitoring wells at the site (including the upgradient well). In addition, trichloroethene was detected in the upgradient well at a concentration of 1,000 micrograms per liter (µg/l) in excess of the MTCA Method A cleanup level. Concentrations of analytes detected in soil samples did not exceed the MTCA Method A soil cleanup levels (Seacor, 1992a).

Soils encountered included a pavement of asphalt or concrete and crushed aggregate base underlain by loose to medium dense, fine to coarse sand, and silty sand (Seacor, 1992a). Groundwater was encountered between 7.5 and 10.0 feet bgs in November 1991. The groundwater flow direction, based on these measurements, was south 22 degrees west with a gradient of 0.002 ft/ft.

Proposed Building 7-027-1/2/3

Ten soil borings and four monitoring wells were completed in the vicinity of these buildings in November 1991 as part of a preconstruction environmental assessment performed by Seacor (1992a). The buildings are located north of the intersection of East Marginal Way and Occidental Avenue.

The following compounds were detected above the MTCA Method A cleanup levels: petroleum hydrocarbons in three monitoring wells, ethylbenzene and xylenes in one monitoring well, and trichloroethylene in one monitoring well (24 µg/l). Analytes were not detected in soil samples at concentrations exceeding the MTCA Method A soil cleanup levels (Seacor, 1992a).

Soils encountered included a pavement of asphalt or concrete and crushed aggregate base underlain by loose to medium dense, fine to coarse sand, and silty sand (Seacor, 1992a). Groundwater was excavated between 9.3 and 11.4 feet bgs in November 1991. The groundwater flow direction, based on these measurements, was south 0 degrees east with a gradient of 0.002 ft/ft.

Utilidor Project

Soils impacted by diesel-range hydrocarbons were encountered during the initial excavation of a utility trench north of the runway at North Boeing Field. Approximately 200 cubic yards of petroleum-impacted soils were excavated from the site and transported to Arlington Landfill in Oregon for disposal (GTI, 1990).

A groundwater sample obtained from the excavation contained concentrations of diesel-range hydrocarbons in excess of the MTCA Method A cleanup levels (GTI, 1990). GTI (1990) concluded that after completion of the excavation, "no additional soils suspected of containing contaminants in the area were encountered...;" however, GTI does not report the collection or analysis of confirmation samples.

Soils encountered during excavation activities were not described by GTI. Water was encountered in the excavation; however, the depth to groundwater was not reported.

Building 3-800

Seacor (1992b) installed eight monitoring wells in the vicinity of Building 3-800 in February and March 1992 to assess subsurface conditions near the former location of a concrete UST (septic tank). The UST was removed in February 1990. One soil sample collected from the base of the resulting excavation contained tetrachloroethene at a concentration exceeding the MTCA Method A cleanup level. Groundwater samples collected from three of the nine monitoring wells yielded concentrations of vinyl chloride, trichloroethene, and/or tetrachloroethene at concentrations exceeding the MTCA Method A cleanup levels.

Beryllium was detected at a concentration exceeding the MTCA Method B cleanup level in one soil sample obtained during the drilling of the monitoring wells at the site (Seacor, 1992b). Other analytes were not detected in the soil samples at concentrations exceeding the MTCA Method A or B cleanup levels.

In March 1992, Seacor collected groundwater samples from eleven monitoring wells. Vinyl chloride, trichloroethene, and/or tetrachloroethene concentrations in six of the monitoring wells exceeded the MTCA Method A or B cleanup levels. In addition, concentrations of arsenic, beryllium, chromium, and/or lead were detected at concentrations greater than the MTCA Method A or B cleanup levels in groundwater samples collected from four of the monitoring wells.

The soils at the site include a surface cover of approximately 4 inches of asphalt underlain by 8 inches of crushed aggregate base. The surface cover is underlain by approximately 8 feet of fine to medium sand. At a depth of approximately 9 feet bgs, a 1- to 2.5-foot thick bed of clayey silt was observed in the majority of borings; however, in two of the borings, pea gravel was encountered in this horizon. Below the clayey silt/pea gravel layer, sand with thin silt stringers was observed to the maximum depth explored of 40 feet (Seacor, 1992b).

Groundwater measurements obtained at the site in March 1992, indicated the occurrence of groundwater at depths ranging from 7.22 to 7.95 feet bgs, with a groundwater flow direction to the west (Seacor, 1992b).

Building 3-801

Hart Crowser (Seacor, 1991a,b) completed 40 test pit excavations and five monitoring wells at the site in 1990 to evaluate petroleum impacts to soil and groundwater related to a heating oil UST. Approximately 1,980 cubic yards of soil with petroleum hydrocarbon concentrations exceeding the MTCA Method A cleanup levels were excavated from the vicinity of the UST in 1990 during UST decommissioning and soil remediation activities. Confirmation soil samples collected from the limits of the remedial excavation did not contain petroleum hydrocarbons at concentrations exceeding the MTCA Method A cleanup levels.

Results of an environmental assessment completed in 1991 by Seacor (1991a,b) in the vicinity of proposed Building 3-801 indicated concentrations of petroleum hydrocarbons greater than MTCA Method A groundwater cleanup levels in soils at the site. Groundwater samples did not contain concentrations of petroleum hydrocarbons exceeding the MTCA Method A cleanup levels.

Removal of approximately 1,745 cubic yards of petroleum-impacted soils, and 500 cubic yards of nonimpacted soils was completed in March

1992 (Seacor, 1992c). Soil with petroleum hydrocarbon concentrations exceeding the MTCA Method A cleanup levels remained near and beneath building footings at the site after the completion of remedial activities.

Results of an environmental assessment completed in 1991 in the vicinity of proposed Building 3-801 indicated concentrations of antimony, arsenic, chromium, and/or lead exceeding MTCA Method A groundwater cleanup levels in groundwater samples collected from two of the four monitoring wells at the site (1991a,b). Concentrations of arsenic in soil samples collected from the soil borings were below MTCA Method A soil cleanup levels, which led Seacor to conclude that the source for the metals concentrations in groundwater at the site has not been identified.

Soils encountered during drilling included fill material consisting of silty sand to sand to depths of 8 to 9 feet bgs. The fill materials were underlain by native soils consisting of organic silt to the total depths explored.

Groundwater flow measured at the Building 3-801 site on September 19, 1991, was approximately north 75 degrees west with a gradient of 0.0003 ft/ft. Seacor (1991a,b) reported groundwater flow direction to the west with a gradient of 0.0015 ft/ft based on July 1991 measurements. Groundwater was encountered between 7.57 and 11.20 feet bgs.

Flight Line Utility Corridor - Concourse C (North Boeing Field Delivery)

Diesel-range hydrocarbons were detected at concentrations exceeding the MTCA Method A cleanup level in soil samples collected from 4 of the 29 soil borings. The borings were completed from August to December 1991 during a preconstruction environmental assessment for a new utility corridor at the site (Seacor, 1992d). Groundwater quality was not assessed as part of the project.

During the period November 1991 through January 1992, petroleum-impacted soils were excavated during trenching activities for the utility corridor. Petroleum hydrocarbons were not detected at concentrations exceeding the MTCA Method A cleanup levels in confirmation soil samples collected from the limits of the remedial excavation areas.

Main Fuel Farm

During the period December 1991 through April 1992, Seacor (1992e) completed two site assessments at the North Boeing Field Main Fuel

Farm. The fuel farm contains two 30,000-gallon and one 6,000-gallon jet fuel ASTs and three jet fuel USTs.

A total of 17 groundwater monitoring wells were installed during site assessment activities. Petroleum hydrocarbons were detected at concentrations exceeding the MTCA Method A cleanup levels in soil samples collected from the monitoring well borings near the USTs. LNAPL was observed in two monitoring wells at the site. Concentrations of petroleum hydrocarbons and/or benzene exceeded the MTCA Method A cleanup levels in samples collected from five of the monitoring wells (excluding monitoring wells containing LNAPLs).

Soils encountered at the site consisted of a concrete slab underlain by crushed aggregate to a depth of 1 to 1.5 feet. Fine to medium sand generally was encountered to depths of 8 to 10.5 feet. This sand unit was underlain by a 2.5-to 5-foot thick zone of organic to nonorganic silt. Fine to medium sand was encountered below this layer to 15 feet, the maximum depth explored at the site (Seacor, 1992e).

Groundwater measurements recorded by Seacor (1992e) in April 1992 indicate static groundwater levels between 6.95 and 8.74 feet bgs. Water level elevations at the site indicate a general groundwater flow direction to the southwest with a gradient of approximately 0.001 ft/ft.

King County Airport Maintenance

In October 1992, two 1,000-gallon gasoline USTs were decommissioned and removed from the King County Airport Maintenance facility at 6518 Ellis Avenue. James P. Hurley Company (1992) reported that petroleum-impacted soils and groundwater were encountered during UST removal and remediation activities at the site.

Approximately 1,000 cubic yards of petroleum-impacted soil were excavated from the vicinity of the USTs and were bioremediated on site. Petroleum hydrocarbons were not detected at concentrations exceeding the MTCA Method A cleanup levels in confirmation soil samples collected from the sidewall limits of the remedial excavation. One sample collected from the base of the excavation contained a concentration of 10,000 mg/kg of gasoline-range hydrocarbons, and concentrations of benzene, toluene, ethylbenzene, and total xylenes (BETX) exceeding the MTCA Method A cleanup levels. In addition, gasoline-range hydrocarbons and BTEX were detected in a groundwater sample collected during UST removal activities at concentrations exceeding the MTCA Method A cleanup levels.

Groundwater was reported at a depth of approximately 10 feet bgs during UST removal and remediation activities. Soils encountered were reported as sand fill to the maximum depth of the excavation (10 feet). Monitoring wells were not installed at the site; consequently, contaminant plume and groundwater flow direction data are not available.

Washington State Motor Pool

In November 1991, a steel, 10,000-gallon, unleaded, gasoline UST was decommissioned and removed from the Washington State Motor Pool facility located at 665 Ellis Avenue South [B & C Equipment Company (B&C), 1992]. Concentrations of gasoline-range hydrocarbons and BTEX in several soil samples collected from the limits of the excavation exceeded the MTCA Method A soil cleanup levels (B&C, 1992).

In December 1991, the UST excavation was extended. Subsequent confirmation soil sampling from the limits of the excavation yielded gasoline-range hydrocarbons and BTEX concentrations below the MTCA Method A soil cleanup levels in all samples.

Approximately 125 cubic yards of petroleum-impacted soil was excavated from the site. This soil was transported to Sterling Asphalt in Lynnwood, Washington for thermal desorption and/or asphalt incorporation.

The total depth of excavation at the site was 12 feet. B&C (1992) reported that native soils at the site consisted of loose medium sand. Medium sand fill was reported above the native soils, but no thickness or depth information was reported. Approximately 1 foot of gravel fill and asphalt pavement were present at the surface. Groundwater was observed as a slight seepage into the remedial excavation at a depth of approximately 12 feet.

Seattle City Light - Georgetown Steamplant

A former power plant owned by Seattle City Light, which is currently vacant, is located approximately 200 feet northeast of Seattle ANGS, adjacent to the Boeing property. This power plant was constructed in the 1890s and apparently used both coal and fuel oil in its operations.

1946 aerial photograph interpretation shows a railroad spur, several large coal piles, and a large fuel oil tank in close proximity to the former power plant. The large fuel oil tank (demolished in 1987) and the former coal piles were all located approximately 600 feet from the boundary of Seattle ANGS (OpTech 1995).

PCBs were detected in soils and sediment in storm sewer lines at the Seattle City Light - Georgetown Steamplant site at 1131 South Elizabeth Street in 1985. PCB-impacted soils were excavated and removed from the site. PCB-impacted sediment in the sewer system was identified and removed from washdown water containment tanks at the site and in storm sewer lines on and off site.

One diesel fuel and three heating oil USTs were decommissioned and removed from the Seattle City Light - Georgetown Steamplant site in March 1989. A total of approximately 1,850 tons of petroleum-impacted soils encountered during UST removal activities were excavated. The petroleum-impacted soils were transported to Sterling Asphalt in Lynnwood, Washington for thermal desorption and/or asphalt incorporation.

No information concerning impacts to groundwater at the site or the current site status was available.

A & T Pump

Several USTs installed at the site during the 1940s were decommissioned and removed in 1985. Although available data indicate that a waste oil tank was formerly present at the site, information concerning the number, size, or contents of the USTs was not available.

Soil sampling completed by a potential buyer of the property indicated that soils at the site were impacted by petroleum hydrocarbons. Soil samples collected from native soils at depths between 12 and 13 feet below bgs were submitted for laboratory analysis. Gasoline-range hydrocarbons were detected in one sample at a concentration of 125 milligrams per kilogram (mg/kg), and diesel-range hydrocarbons were detected in two soil samples at concentrations of 250 mg/kg and 270 mg/kg. Motor-oil range hydrocarbons were detected at a concentration of 1,200 mg/kg in one soil sample collected in the vicinity of the former waste oil UST location.

Approximately 10 to 11 feet of fill was excavated. Information on underlying native fill was not available. Groundwater was encountered at approximately 14 feet bgs during soil sampling activities.

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The EDR-Radius Map
with GeoCheck™

Seattle ANGS
6736 Ellis Avenue South
Seattle, WA 98108

Inquiry Number: 195003.3p

November 01, 1995

EDR Environmental Data Resources, Inc.

Creators of Toxicheck/®

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with any questions or comments.

Disclaimer

EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc. (EDR). The search met the specific requirements of ASTM Standard Practice for Environmental Site Assessments, E 1527-94, or custom distances requested by the user.

The address of the subject property for which the search was intended is:

6736 ELLIS AVENUE SOUTH
SEATTLE, WA 98108

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the subject property or within the ASTM E 1527-94 search radius around the subject property for the following Databases:

(b)(4) copyright

Unmapped (orphan) sites are not considered in the foregoing analysis.

Search Results:

Search results for the subject property and the search radius, are listed below:

Subject Property:

(b)(4) copyright

(b)(4) copyright

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(b)(4) copyright

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Appendix C

APPENDIX C

MODEL TOXICS CONTROL ACT RISK ASSESSMENT PROCEDURES AND BACKGROUND METALS INFORMATION

WAC 173-340-708 Human Health Risk Assessment Procedures.

(1) Purpose. This section defines the risk assessment framework that the department will utilize to establish cleanup levels.

(2) Selection of indicator hazardous substances.

(a) When defining cleanup requirements at a site that is contaminated with a large number of hazardous substances, the department may eliminate from consideration those hazardous substances that contribute a small percentage of the overall threat to human health and the environment. The remaining hazardous substances shall serve as indicator hazardous substances for purposes of defining site cleanup requirements.

(b) If the department considers this approach appropriate for a particular site, the factors evaluated when eliminating individual hazardous substances from further consideration shall include:

(i) The toxicological characteristics of the hazardous substance that influence its ability to adversely affect human health or the environment relative to the concentration of the hazardous substance at the site;

(ii) The chemical and physical characteristics of the hazardous substance which govern its tendency to persist in the environment;

(iii) The chemical and physical characteristics of the hazardous substance which govern its tendency to move into and through environmental media;

(iv) The natural background concentrations of the hazardous substance;

(v) The thoroughness of testing for the hazardous substance at the site;

(vi) The frequency that the hazardous substance has been detected at the site; and

(vii) Degradation by-products of the hazardous substance.

(c) When the department determines that the use of indicator hazardous substances is appropriate for a particular site, it may also require biological testing to address potential toxic effects associated with hazardous substances eliminated from consideration under this subsection.

(3) Reasonable maximum exposure.

(a) Cleanup levels shall be based on estimates of current and future resource uses and reasonable maximum exposures expected to occur under both current and potential future site use conditions.

(b) The reasonable maximum exposure is defined as the highest exposure that is reasonably expected to occur at a site under current and potential future site use. WAC 173-340-720 through 173-340-760 define the reasonable maximum exposures for ground water, surface water, soil, and air. These reasonable maximum exposures will apply to most sites where individuals or groups of individuals are or could be exposed to hazardous substances. For example, the reasonable maximum exposure for most ground water is defined as exposure to hazardous substances in drinking water and other domestic uses.

(c) Persons performing cleanup actions under this chapter may utilize the evaluation criteria in WAC 173-340-720 through 173-340-760 to demonstrate that the reasonable maximum exposure scenarios specified in those sections are not appropriate for a particular site. The use of an alternate exposure scenario shall be documented by the person performing the cleanup action. Documentation for the use of alternate exposure scenarios shall be based on the results of investigations performed in accordance with WAC 173-340-350.

(d) Individuals or groups of individuals may be exposed to hazardous substances through more than one exposure pathway. For example, a person may be exposed to hazardous substances from a site by drinking contaminated ground water, eating contaminated fish, and breathing contaminated air. At sites where the same individuals or groups of individuals are or could be consistently exposed through more than one pathway, the reasonable maximum exposure shall represent the total exposure through all of those pathways. At such sites, the cleanup levels derived for individual pathways under WAC 173-340-720 through 173-340-760 shall be adjusted downward to take into account multiple exposure pathways.

(4) Cleanup levels for individual hazardous substances. Cleanup levels for individual hazardous substances will generally be based on a combination of requirements in applicable state and federal laws and risk assessment.

(5) Multiple hazardous substances.

(a) Cleanup levels for individual hazardous substances established under methods B and C shall be adjusted downward to take into account exposure to multiple hazardous substances. Adverse effects resulting from exposure to two or more hazardous substances with similar types of toxic response are assumed to be additive unless scientific evidence is available to demonstrate otherwise.

(b) Cancer risks resulting from exposure to two or more carcinogens are assumed to be additive unless scientific evidence is available to demonstrate otherwise.

(c) For purposes of establishing cleanup levels for noncarcinogens under methods B and C, the health threats resulting from exposure to two or more hazardous substances with similar types of toxic response may be apportioned between those hazardous substances in any combination as long as the hazard index does not exceed one (1).

(d) For purposes of establishing cleanup levels for carcinogens under methods B and C, the cancer risks resulting from exposure to multiple hazardous substances may be apportioned between hazardous substances in any combination as long as the total excess cancer risk does not exceed one in one hundred thousand.

(e) The department may require biological testing to assess the potential interactive effects associated with chemical mixtures.

(6) Multiple pathways of exposure.

(a) Estimated doses of individual hazardous substances resulting from more than one pathway of exposure are assumed to be additive unless scientific evidence is available to demonstrate otherwise.

(b) Cleanup levels based on one pathway of exposure shall be adjusted downward to take into account exposures from more than one exposure pathway. The number of exposure pathways considered at a given site shall be based on the reasonable maximum exposure scenario as defined in WAC 173-340-708(3).

(c) For purposes of establishing cleanup levels for noncarcinogens under methods B and C, the health threats associated with exposure via multiple pathways may be apportioned between exposure pathways in any combination as long as the hazard index does not exceed one (1).

(d) For purposes of establishing cleanup levels for carcinogens under methods B and C, the cancer risks associated with exposure via multiple pathways may be apportioned between exposure pathways in any combination as long as the total excess cancer risk does not exceed one in one hundred thousand.

(7) Reference doses.

(a) The chronic reference dose and the developmental reference dose shall be used to establish cleanup levels under this chapter. Cleanup levels shall be established using the value which results in the most protective concentration.

(b) Inhalation reference doses shall be used in WAC 173-340-750. Where the inhalation reference dose is reported as a concentration in air, that value shall be converted to a corresponding inhaled intake (mg/kg-day) using a human body weight of 70 kg and an inhalation rate of 20 m^3/day.

(c) A subchronic reference dose may be utilized to evaluate potential noncarcinogenic effects resulting from exposure to hazardous substances over short periods of time. This value may be used in place of the chronic reference dose where it can be demonstrated that a particular hazardous substance will degrade to negligible concentrations during the exposure period.

(d) For purposes of establishing cleanup levels for hazardous substances under this chapter, a reference dose established by the United States Environmental Protection Agency and available through the "integrated risk information system" data base shall be used unless the department determines that there is clear and convincing scientific data which demonstrates that the use of this value is inappropriate.

(e) If a reference dose is not available through the "integrated risk information system" or is demonstrated to be inappropriate under (d) of this subsection, a reference dose shall be established utilizing the methods described in Risk Assessment Guidance for Superfund. Human Health Evaluation Manual, Part A. (October 1989.)

(f) In estimating a reference dose for a hazardous substance under (e) of this subsection, the department shall consult with the science advisory board, the department of health, and the United States Environmental Protection Agency.

(g) Where a reference dose other than those established under (d) of this subsection is used to establish a cleanup level at individual sites, the department shall summarize the scientific rationale for the use of those values in the cleanup action plan. The department shall provide the opportunity for public review and comment on this value in accordance with the requirements of WAC 173-340-360 and 173-340-600.

(8) Carcinogenic potency factor.

(a) For purposes of establishing cleanup levels for hazardous substances under this chapter, a carcinogenic potency factor established by the United States Environmental Protection Agency and available through the "integrated risk information system" data base shall be used unless the department determines that there is clear and convincing scientific data which demonstrates that the use of this value is inappropriate.

(b) If a carcinogenic potency factor is not available through the "integrated risk information system" or is demonstrated to be inappropriate under (a) of this subsection, one of the following methods shall be utilized to establish a carcinogenic potency factor:

(i) The carcinogenic potency factor may be derived from appropriate human epidemiology data on a case-by-case basis; or

(ii) The carcinogenic potency factor may be derived from animal bioassay data using the following procedures:

(A) All carcinogenesis bioassays shall be reviewed and data of appropriate quality shall be used for establishing the carcinogenic potency factor.

(B) The linearized multistage extrapolation model shall be utilized to estimate the slope of the dose-response curve unless the department determines that there is clear and convincing scientific data which demonstrates that the use of an alternate extrapolation model is more appropriate;

(C) All doses shall be adjusted to give an average daily dose over the study duration; and

(D) An interspecies scaling factor shall be used to take into account differences between animals and humans. This scaling factor shall be based on the assumption that milligrams per surface area is an equivalent dose between species unless the department determines there is clear and convincing scientific data which demonstrates that an alternate procedure is more appropriate. The slope of the dose response curve for the test species shall be multiplied by this scaling factor in order to obtain the carcinogenic potency factor, except where such scaling factors are incorporated in the extrapolation model under (B) of this subsection. Where adequate pharmacokinetic and metabolism studies are available, data from these studies may be utilized to adjust the interspecies scaling factor.

(c) In estimating a carcinogenic potency factor for a hazardous substance under (b) of this subsection, the department shall consult with the science advisory board, the department of health, and the United States Environmental Protection Agency.

(d) Where a carcinogenic potency factor other than that established under (a) of this subsection is used to establish cleanup levels at individual sites, the department shall summarize the scientific rationale for the use of that value in the cleanup action plan. The department shall provide the opportunity for public review and comment on this value in accordance with the requirements of WAC 173-340-360 and 173-340-600.

(9) Bioconcentration factors.

(a) For purposes of establishing cleanup levels for a hazardous substance under WAC 173-340-730, a bioconcentration factor established by the United States Environmental Protection Agency and utilized to establish the ambient water quality criterion for that substance under section 304 of the Clean Water Act shall be used unless the department determines that there is clear and convincing scientific data which demonstrates that the use of an alternate value is more appropriate.

(b) When utilizing a bioconcentration factor other than that utilized to establish the ambient water quality criterion, the department shall consult with the science advisory board, the department of health, and the United States Environmental Protection Agency.

(c) Where a bioconcentration factor other than that established under (a) of this subsection is used to establish cleanup levels at individual sites, the department shall summarize the scientific rationale for the use of that factor in the draft cleanup action plan. The department shall provide the opportunity for public review and comment on the value in accordance with the requirements of WAC 173-340-360 and 173-340-600.

(10) Exposure parameters.

(a) As a matter of policy, the department has defined the exposure parameters to be used when establishing cleanup levels under this chapter. With the exception of the parameters identified in (b) of this subsection, these parameters shall not be modified for individual hazardous substances or sites in a manner which results in a less stringent cleanup level. The scientific and technical basis for these parameters shall be reviewed when updating this chapter under WAC 173-340-704(3).

(b) The department may approve the use of values other than those specified in WAC 173-340-720 through 173-340-760 where there is clear and convincing scientific data which demonstrates that one or more of the following parameters should be modified for an individual hazardous substance or site:

(i) Gastrointestinal absorption rate;

(ii) Inhalation correction factor;

(iii) Bioconcentration factor; or

(iv) Inhalation absorption rate.

(c) Where exposure parameters other than those established under WAC 173-340-720 through 173-340-760 are used to establish cleanup levels at individual sites, the department shall summarize the scientific rationale for the use of those parameters in the cleanup action plan. The department shall provide the opportunity for public review and comment on those values in accordance with the requirements of WAC 173-340-360 and 173-340-600.

(11) Methods for defining background concentrations.

(a) Sampling of hazardous substances in background areas may be conducted to distinguish site-related concentration from nonsite related concentrations of hazardous substances or to support the development of a method C cleanup level under the provisions of WAC 173-340-706. For purposes of this chapter, two types of background may be determined, natural background and area background concentrations.

(b) For purposes of defining background concentrations, samples shall be collected from areas that have the same basic characteristics as the medium of concern at the site, have not been influenced by releases from the site and, in the case of natural background concentrations, have not been influenced by releases from other localized human activities.

(c) The statistical method used to evaluate available data shall be appropriate for the distribution of each hazardous substance. If the distribution of the hazardous substance data is inappropriate for statistical methods based on a normal distribution, then the data may be transformed. If the distributions of individual hazardous substances differ, more than one statistical method may be required at a site. In general, appropriate statistical methods include the following:

(i) A tolerance interval procedure in which an interval for each hazardous substance is established from the distribution of background data and the cleanup level of each hazardous substance is compared to the lower tolerance limit; and

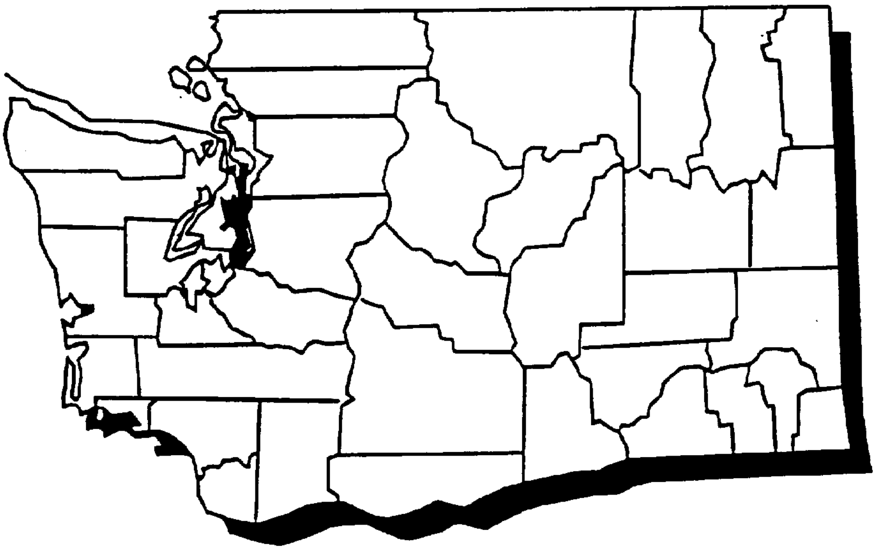
(ii) Other statistical methods proposed by the person undertaking the cleanup action and approved by the department.

(d) If a tolerance interval approach is used to evaluate natural background data, the tolerance interval shall have a coverage of ninety-five percent and a tolerance coefficient of ninety-five percent. When determining natural background concentrations, sample size of ten or more background soil samples shall be required. When determining area background concentrations, a sample size of twenty or more soil samples shall be required. The number of samples for other media shall be sufficient to provide a representative measure of background concentrations and shall be determined on a case-by-case basis.

(e) For purposes of estimating background concentrations, values below the method detection limit shall be assigned a value equal to one-half of the method detection limit. Measurements above the method detection limit, but below the practical quantitation limit shall be assigned a value equal to the method detection limit. The department may approve the use of alternate statistical procedures for handling data below the method detection limit or practical quantitation limit. Alternate statistical procedures may include probit analysis and regression analysis.

(12) Significant figures. Risk assessment results shall be presented using one significant figure.

[Statutory Authority: Chapter 70.105D RCW. 91-04-019, §173-340-708, filed 1/28/91, effective 2/28/91.]



Natural Background Soil Metals Concentrations in Washington State

Toxics Cleanup Program
Department of Ecology

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

October, 1994
Publication #94-115

printed on recycled paper

VIII. USE AND APPLICATION OF BACKGROUND VALUES

Site-Specific or Area Studies of Natural Background

The intent of this report is to provide detailed information on the natural background concentration of metals in soils throughout Washington State. However, site-specific assessments of natural or area background can still be initiated if desired. At least ten samples must be collected for a site-specific study into natural background and at least 20 are required for area background (Ch 173-340-708 11 (d) WAC).

Use of the Statewide and Regional Values

Statewide and regional 90th percentile values for the Puget Sound Basin, Clark County, Yakima Basin, and Spokane Basin are presented in **Table 6**. The statewide values can be used for any purpose (i.e., comparison against data from toxic waste sites, waste streams, etc.) and there are no restrictions on the use of this data. The regional 90th percentile values for Puget Sound, Clark County, Yakima Basin, and Spokane Basin are to be compared against data from those regions only (see Table 12 below).

Table 12: Counties Encompassed by Regional Background Values

Region	Counties
Puget Sound Basin	Clallam, Jefferson, Mason, Thurston, Pierce, King, Kitsap, Island, Snohomish
Clark County	Clark, Cowlitz, Skamania
Yakima Basin	Yakima, Kittitas, Klickitat, Chelan, Benton
Spokane Basin	Spokane, Lincoln, Adams, Whitman

Other Areas

Sites that are not located within the four main regional areas may use the statewide values or the 10 sampling locations (see latitude/longitude coordinates, data tables) that are closest to a given site or area.

Application of Background Values

When comparing cleanup- or contaminated-site data against background values, the 95% upper confidence limit (UCL) of a given data set is compared against the 90th percentile of the background data set. Please refer to Ecology's publication entitled *Statistical Guidance for Ecology Site Managers* (August, 1992). Detailed instructions on how to derive soil cleanup standards based on background standards are included in that document. Please use caution when comparing individual data points against the 90th percentile value of the background data set. When comparing individual data points against the 90th percentile value, there is a 10% chance that an individual data point will exceed the 90th percentile value.

Alternative Procedures

The 90th percentile has been selected by Ecology as the default assumption for determining background. If background values are used as cleanup levels, no single sample concentration shall be greater than two times the 90th percentile value and less than ten percent of the sample concentrations shall exceed the 90th percentile value (Ch 173-340-740 (7) (e), see **Table 13**). However, alternative procedures for determining background are allowed. Specifically, a numerical cleanup standard is established, based on different data evaluation procedures. This could be the result of site-specific characteristics, such as the form of the background data distribution, its coefficient of variation (CV) or degree of skew, the number of samples available, or other such factors. For more information on alternative procedures for determining background, consultant Ecology's *Statistical Guidance for Site Managers* (August, 1992, see flowchart of p. 38 for alternative procedures).

TABLE 13: 90th PERCENTILE VALUES

ALL VALUES = MG/KG

	Al		As		Be		Cd		Cr		Cu	
GROUP "W"	62,905	125,810	8.47	16.9	0.8	1.5	0.1	0.2	78.5	156.9	52.9	105.7
PUGET SOUND	32,581	65,162	7.30	14.6	0.6	1.2	0.8	1.6	48.2	96.3	36.4	72.7
CLARK COUNTY	52,276	104,552	5.81	11.6	2.1	4.1	0.9	1.9	26.6	53.1	34.4	68.9
WEST (ALL)	45,735	91,470	6.37	12.7	1.5	3.0	1.2	2.4	47.4	94.8	43.2	86.5
STATEWIDE	37,206	74,412	6.99	14.0	1.4	2.9	1.0	2.0	41.9	83.8	36.0	72.0
EAST (ALL)	28,299	56,598	7.61	15.2	1.3	2.6	0.8	1.6	31.9	63.8	28.4	56.8
YAKIMA BASIN	33,379	66,758	5.13	10.3	1.6	3.1	0.9	1.9	38.3	76.5	26.5	52.9
SPOKANE BASIN	21,376	42,752	9.34	18.7	0.8	1.7	0.7	1.4	17.8	35.6	21.6	43.2
GROUP "E"	25,591	51,182	5.76	11.5	0.6	1.2	N/A	N/A	37.8	75.6	28.4	56.8

	Fe		Hg		Mn		Ni		Pb		Zn	
GROUP "W"	49,170	98,340	0.13	0.26	691.8	1,384	54.2	108.4	10.9	21.7	85.6	171.1
PUGET SOUND	36,128	72,256	0.07	0.14	1146.0	2,292	38.2	76.4	16.8	33.7	85.1	170.1
CLARK COUNTY	58,665	117,330	0.04	0.08	1511.0	3,022	21.0	42.1	24.0	48.0	95.5	191.0
WEST (ALL)	50,125	100,250	0.08	0.16	1337.3	2,675	44.2	88.4	20.4	40.8	98.4	196.8
STATEWIDE	43,106	86,212	0.07	0.14	1094.9	2,190	38.2	76.4	17.1	34.2	85.8	171.6
EAST (ALL)	36,644	73,288	0.04	0.08	836.0	1,672	24.5	49.1	13.1	26.2	80.9	161.8
YAKIMA BASIN	51,451	102,902	0.05	0.10	1104.8	2,210	45.9	91.8	11.0	22.0	78.7	157.4
SPOKANE BASIN	25,026	50,052	0.02	0.04	663.5	1,327	16.2	32.4	14.9	29.8	66.4	132.8
GROUP "E"	29,631	59,262	0.02	0.04	526.6	1,053	22.4	44.8	9.9	19.7	67.5	134.9

SHADED COLUMN = TWICE THE 90th PERCENTILE VALUE

NOTE ON COMPLIANCE MONITORING: A) NO SINGLE SAMPLE CONCENTRATION SHALL BE GREATER THAN TWO TIMES THE 90th PERCENTILE VALUE, B) LESS THAN TEN PERCENT OF THE SAMPLE CONCENTRATIONS SHALL EXCEED THE SOIL CLEANUP LEVEL. Ch 173-340-740 (7) (e) WAC.

Appendix D

APPENDIX D

QUALITY ASSURANCE PROJECT PLAN

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APPENDIX D

QUALITY ASSURANCE PROJECT PLAN

This section presents the site-specific Quality Assurance Project Plan (QAPP) for RI/FS activities at Seattle ANGS.

1.1 Project Description

This site-specific QAPP presents the overall policies, data quality objectives, specific QA and QC requirements, procedures, responsibilities, chain-of-custody procedures, laboratory analyses, and documentation that will be employed during RI/FS activities.

1.2 RI/FS Description

The overall objective of the RI is to provide an accurate, precise, and representative summary of the current vertical and horizontal extent of contamination within the soil and groundwater associated with IRP Site 1 - Burial Site. Information obtained during the investigation will be used during the FS phase as the scientific basis for identifying and selecting the most appropriate remedial alternatives for the site. This QAPP provides information regarding data collection and QA activities and procedures to ensure that valid data are collected during the RI for subsequent use in the FS decision process.

1.3 RI/FS Project Objectives

The purpose and objective of the QAPP is to establish standard procedures to ensure that the integrity, accuracy, precision, completeness, and representativeness of the samples are maintained in order to support the objectives of the RI/FS. The specific objectives of the RI/FS are stated below.

- Provide additional data to assist in defining the vertical and horizontal extent and magnitude of soil and groundwater contamination at the investigated site.

- Determine site-specific background concentrations in soil and groundwater.
- Refine the understanding of the pathways of contaminant migration.
- Define site physical features, facilities, and hydrogeologic conditions that could affect contaminant migration, containment, or cleanup.
- Determine the nature and extent of threat to human health and the environment.
- Determine the types of response actions to be considered (decision document, FS, remedial design, or remedial action).
- Develop, screen, and evaluate potential remedial alternatives.
- Recommend the most cost-effective remedial alternatives that adequately protect human health, welfare, and the environment.

1.3.1 Data Usage

The data collected during this RI/FS will provide the basis for decisions on remedial measures to ensure that concentrations of identified contaminants are less than applicable State and Federal standards. Specifically, the data collected during this investigation will be used to:

- Characterize sources of contamination and pathways;
- Calculate site-specific background concentrations;
- Determine the nature and extent of contamination; and
- Support the selection of cost-effective remedial technologies and alternatives.

1.3.2 Data Quality Objectives (DQOs)

Data quality objectives (DQOs) are quantitative and qualitative statements specified to ensure that data of known and appropriate quality are obtained during the RI/FS activities to support the selection of appropriate corrective measures. DQOs are selected based on the specific use of the data collected.

1.3.3 Integration of DQOs

DQOs were developed through a three-stage process. The DQO process is an integral part of work plan development, which includes field screening and sampling, sample transshipment to the analytical laboratory, sample analysis, and reporting. The DQO process will be revised, as needed, based upon the results of each data collection activity. The general DQO development process is outlined in Table D-1.

TABLE D-1

DQO Three-Stage Development
143rd CCSQ, Seattle ANGS, Seattle, Washington

STAGE	DESCRIPTION
1	Stage 1 of the DQO process identifies the individuals responsible for decisions, data uses, and available data; and determines if additional data is needed and the types of decisions that will be made regarding site remediation. Stage 1 specifies the decision making process, identifies why additional data are needed, and sets the foundation for Stages 2 and 3 of the DQO development process.
2	Stage 2 specifies the data (quantity and quality) necessary to meet the objectives set in Stage 1. This stage stipulates the criteria for determining data adequacy. Stage 2 includes selection of the sampling approaches and the analytical options used for each site.
3	Stage 3 specifies how to assemble data collection components and develop data collection documentation. Methods were specified by which acceptable data will be obtained to make decisions. This information will be provided in the site-specific sampling plan.

1.3.4 Stages of DQOs

Stage 1 DQOs applicable to the RI/FS include the following:

- The Project/Site Manager will be responsible for all decisions regarding actions taken to respond to field data. They are also responsible for determining personal protection levels, for example, in response to site monitoring readings by field personnel. In all cases, the health and safety of field personnel will be protected.

- The Project/Site Manager will be responsible for ensuring that all field equipment is calibrated before use each day according to manufacturers' instructions. All calibration actions will be recorded in the field log in indelible ink.

- Field readings will be used to initially characterize each site during drilling and sampling activities. The field sampling plan may be modified by the Project/Site Manager if readings indicate an increased level of contamination, in order to accurately assess the contamination parameters.

Stage 2 DQOs applicable to the RI/FS include the following:

- The field geologist will be responsible for ensuring that the required volume of each sample matrix is collected to ensure that complete laboratory analysis objectives are met.

- The field geologist is responsible for ensuring that all QA/QC samples are collected in accordance with the field sampling plan and this QAPP.

- Personnel exposure to airborne contaminants will not exceed applicable Threshold Limit Values. Sites will be continuously screened to ensure that field personnel are not exposed to contaminants that would be harmful to their health and safety.

- Samples will be strictly controlled in accordance with ANG/CEVR site investigation protocols. Samples will be collected using only decontaminated equipment. The Project/Site Manager will be responsible for ensuring that ANG/CEVR protocols for decontamination and sampling are met. In accordance with the field sampling plan, care will be taken to eliminate cross-contamination during sampling activities.

Stage 3 DQOs applicable to the RI/FS include the following:

- Documentation is key to ensuring that the highest levels of accuracy, precision, completeness, representativeness, and comparability are met. Accordingly, all field personnel will be trained and thoroughly familiar with standard documentation requirements. Training will include information on how analytical data will be used for site investigation decisions.

- The work plan will be approved by ANG/CEVR prior to implementation and will include complete matrix and QA/QC sampling requirements.

- All field notes taken during sampling activities will be recorded in the field log book using indelible ink.

- Samples will be immediately labeled using a standard sample label, with all required data elements included.

- Sample data will be immediately entered into the Chain-of-Custody Record to ensure proper tracking and control.
- Samples will be shipped in sealed containers and accompanied by the Chain-of-Custody Record.
- QA/QC samples, including trip blanks, equipment blanks, field duplicates, and matrix spike/matrix spike duplicates will be collected, controlled, and shipped in the same manner as normal field samples, to ensure that field collection protocols will produce accurate site data and that laboratory analytical procedures fully meet the highest standards of performance.
- Complete and traceable Chain-of-Custody Records are maintained for samples and are documented evidence that proper sampling and QA/QC protocols were observed in data collection and analysis. Only traceable data will be used for decision making regarding further sampling requirements, site remediation, or site close-out.

1.4 QA Objectives for Measurement Data

The overall QA objective is to develop and implement procedures that will ensure quality in field sampling, field testing, Chain-of-Custody, laboratory analysis, data analysis, and data reporting. Specific procedures for sampling, Chain-of-Custody, audits, preventive maintenance, and corrective actions are described in other sections of this QAPP. This section defines the goals for accuracy, precision, completeness, representativeness, and comparability. QA goals for field measurements are also discussed.

1.4.1 Regulatory Parameters

Analysis of groundwater and soil samples collected according to the RI/FS Work Plan will be performed in accordance with analytical procedures that conform to EPA guidelines published in *Test Methods for Evaluating Solid Wastes (SW-846), Third Edition* (update package, December 1997).

Washington groundwater and soil remediation standards are presented in Table D-2. Soil and groundwater standards will be recalculated as necessary for the RI report to account for changes in MCLs and based on changes in toxicological data as included in MTCA risk calculation updates. Tables D-3 through D-8 summarize the detection levels and/or quantitation limits for VOCs, SVOCs,

TABLE D-2

Washington Groundwater and Soil Remediation Standards
143rd CCSQ, Seattle ANGS, Seattle, Washington

ANALYTICAL GROUP	GROUNDWATER Concentration in µg/l				SOILS Concentration in mg/kg	
	Primary MCL	Secondary MCL	MTCA - Method A	MTCA - Method B	MTCA - Method A Residential/Industrial	MTCA - Method B
VOLATILE ORGANIC COMPOUNDS (VOCS)						
Benzene	5	--	5.0	**1.5**	0.5 / 0.5	34.5
Bromodichloromethane	100*	--	--	**0.7**	--	16.1
Bromoform	100*	--	--	5.5	--	127
Bromomethane	--	--	--	11.2	--	112
Carbon disulfide	--	--	--	800	--	8000
Carbon tetrachloride	5	--	--	**0.33**	--	7.7
Chloroform	100*	--	--	7.17	--	164
Chlorobenzene	100	--	--	160	--	1600
Ethylbenzene	700	--	30	800	20 / 20	8000
Methylene chloride	5	--	5	--	0.5 / 0.5	--
Toluene	1,000	--	40	1600	40 / 40	16000
Trichloroethylene	5	--	5	**3.98**	0.5 / 0.5	90.9
Tetrachloroethylene	5	--	5	**0.86**	0.5 / 0.5	19.6
Trihalomethanes (total)	100*	--	--	--	--	--
1,2-Dichloroethane	5	--	5	**0.48**	--	11
cis-1,2-Dichloroethylene	70	--	--	80	--	800
trans-1,2-Dichloroethylene	100	--	--	160	--	16000
1,1-Dichloroethylene	7	--	--	**0.07**	--	1.67
Styrene	100	--	--	**1.46**	--	33.3
1,2-Dichloropropane	5	--	--	**0.64**	--	14.7
1,1,2,2-Tetrachloroethane	--	--	--	**1.68**	--	38.5
1,1,1-Trichloroethane	200	--	200	7200	20 / 20	72000
Vinyl Chloride	2	--	0.2	**0.02**	--	0.53
1,1,2-Trichloroethane	5	--	--	**0.77**	--	17.5
Xylenes (total)	10,000	--	20	16000	20 / 20	160000
Monochlorobenzene	100	--	--	--	--	--
1,3-Dichlorobenzene	75	--	--	--	--	--
1,4-Dichlorobenzene	600	--	--	**1.8**	--	41.7
SEMIVOLATILE ORGANIC COMPOUNDS (SVOCS)				--	--	--
PAHs (carcinogenic)	--	--	0.1	0.012	1 / 20	--
PETROLEUM HYDROCARBONS						
TPH (gasoline)	--	--	1,000		100 / 100	--
TPH (diesel)	--	--	1,000		200 / 200	--
TPH (other)	--	--	1,000		200 / 200	--
POLYCHLORINATED BIPHENYLS (PCBs)						
PCB Mixtures	--	--	0.1	0.009	1 / 10	0.112
METALS						
Arsenic	50	--	5	**0.05**	20 / 200	1.43
Barium	2,000	--	--	1120	--	5600
Beryllium	4	--	--	**0.02**	--	0.233
Cadmium	5	--	5	8	2 / 10	--
Chromium (total)	100	--	50	--	100 / 500	--
Copper	--	--	--	592	--	2660
Lead	--	--	5	--	250 / 1000	
Mercury (inorganic)	2	--	2	4.8	1 / 1	24
Selenium	50	--	--	80	--	400
Silver	--	100	--	80	--	400
RADIONUCLIDES						
Gross Alpha Particle (pCi/l)	15	--	15	--	--	--
Radium-226	3	--	3	--	--	--
Combined Radium-226 & Radium-228	5	--	5	--	--	--
Gross Beta Particle**	50	--	4	--	--	--

Sources: WDOE, 1993 and 1994
µg/l = micrograms per liter
mg/kg = milligrams per kilogram
-- = Not available
MCL = Federal Maximum Contaminant Level
* MCL for total trihalomethanes including bromoform, bromodichloromethane, chloroform, and dibromochloromethane
** Limit on average annual concentration
MTCA Method A/B = Model Toxics Control Act
TPH = Total Petroleum Hydrocarbons
PAHs = Polyaromatic Hydrocarbons
pCi/l = picoCuries per liter
bolded = PQL is greater than cleanup standards

TABLE D-3

Accuracy, Precision, and PQL Limits for Method 8260
143rd CCSQ, Seattle ANGS, Seattle, Washington

Target Analytes	Soil PQL µg/kg	Soil QC Limits (a) % Recovery	Soil QC Limits (a) RPD	Groundwater PQL µg/l	Groundwater QC Limits (a) % Recovery	Groundwater QC Limits (a) RPD
Chloromethane ·	5			5		
Vinyl Chloride	5			5		
Bromomethane	5			5		
Chloroethane	5			5		
Trichlorofluoromethane	5			5		
Acetone	10			10		
2-Chloroethyl vinyl ether	20			20		
1,1-Dichloroethylene	5	59 - 172	22	5	64 - 124	14
Methylene Chloride	5			5		
Carbon Disulfide	5			5		
Vinyl Acetate	10			10		
1,1-Dichloroethane	5			5		
2-Butanone	10			10		
trans-1,2-Dichloroethylene	5			5		
cis-1,2-Dichloroethylene	5			5		
Chloroform	5			5		
1,1,1-Trichloroethane	5			5		
Carbon Tetrachloride	5			5		
1,2-Dichloroethane	5			5		
Benzene	5	66 - 142	21	5	67 - 127	11
Trichloroethylene (TCE)	5	62 - 137	24	5	60 - 120	14
1,2-Dichloropropane	5			5		
Bromodichloromethane	5			5		
4-Methyl-2-pentanone	10			10		
2-Hexanone	10			10		
cis-1,3-Dichloropropene	5			5		
trans-1,3-Dichloropropene	5			5		
1,1,2-Trichloroethane	5			5		
Toluene	5	59 - 139	21	5	72 - 132	13
Dibromochloromethane	5			5		
Tetrachloroethylene (PCE)	5			5		
Chlorobenzene	5	60 - 133	21	5	68 - 128	13
Ethylbenzene	5			5		
m,p-Xylenes	5			5		
o-Xylene	5			5		
Styrene	5			5		
Bromoform	5			5		
1,1,2,2-Tetrachloroethane	5			5		
1,3-Dichlorobenzene	5			5		
1,4-Dichlorobenzene	5			5		
1,2-Dichlorobenzene	5			5		

PQL- Practical Quantitation Limit
LCS - Laboratory Control Sample
QC - Quality Control
RPD - Relative Percent Difference
µg/kg - micrograms per kilogram
µg/l - micrograms per liter
a - Limits should be viewed as goals and not as a means of accepting or rejecting data. QC Limits apply to both Matrix Spike and LCS recoveries.

TABLE D-4

Accuracy, Precision, and PQL Limits for Methods 8010/8020
143rd CCSQ, Seattle ANGS, Seattle, Washington

Target Analytes	PQL µg/l	QC Limits (a) % Recovery	RPD
Dichlorodifluoromethane	5		
Chloromethane	5		
Bromomethane	5		
2-Chloroethylvinyl ether	10		
Vinyl Chloride	5		
Chloroethane	5		
Methylene Chloride	1		
Trichlorofluoromethane	5		
1,1-Dichloroethylene	1		
1,1-Dichloroethane	1		
trans-1,2-Dichloroethylene	1	20	75-125
Chloroform	1		
1,2-Dichloroethane	1	20	75-125
1,1,1-Trichloroethane	1	20	75-125
Carbon Tetrachloride	1		
Bromodichloromethane	1	20	75-125
1,2-Dichloropropane	1		
trans-1,3-Dichloropropene	1	20	75-125
Trichloroethylene	1		
Chlorodibromomethane	1		
1,1,2-Trichloroethane	1	20	75-125
cis-1,3-Dichloropropene	1	20	75-125
Bromoform	2	20	75-125
1,1,2,2-Tetrachloroethane	2		
Tetrachloroethylene	2		
Chlorobenzene	2		
Benzene	1	20	75-125
Toluene	1	20	75-125
Ethylbenzene	1	20	75-125
p-xylene	1		
m-xylene	1		
o-xylene	1		
1,2-Dichlorobenzene	5		
1,3-Dichlorobenzene	5		
1,4-Dichlorobenzene	5		

Note: Sample PQLs are highly matrix-dependent. The PQLs listed in the table are provided for guidance and may not always be achieveable.

PQL- Practical Quantitation Limit
LCS - Laboratory Control Sample
QC - Quality Control
RPD - Relative Percent Difference
µg/l - micrograms per liter
a - Limits should be viewed as goals and not as a means of accepting or rejecting data. QC Limits apply to both Matrix Spike and LCS recoveries.

TABLE D-5

Accuracy, Precision, and PQL Limits for Method 8270
143rd CCSQ, Seattle ANGS, Seattle, Washington

	Soil			Groundwater		
	PQL	QC Limits (a)		PQL	QC Limits (a)	
Target Analytes	mg/kg	% Recovery	RPD	mg/l	% Recovery	RPD
Acenapthene	0.66	31 - 137	19	0.01	47 - 145	31
Acenaphthylene	0.66			0.01		
Anthracene	0.66			0.01		
Benzo(a)anthracene	0.66			0.01		
Benzo(b)fluoranthene	0.66			0.01		
Benzo(k)fluoranthene	0.66			0.01		
Benzo(g,h,i)perylene	0.66			0.01		
Benzo(a)pyrene	0.66			0.01		
Benzyl alcohol	1.30			0.02		
bis(2-Chloroethoxy)methane	0.66			0.01		
bis-(2-Chloroethyl)ether	0.66			0.01		
bis(2-Chloroisopropyl)ether	0.66			0.01		
bis(2-Ethylhexyl)phthalate	0.66			0.01		
4-Bromophenyl phenyl ether	0.66			0.01		
Benzyl butyl phthalate	0.66			0.01		
4-Chloroaniline	1.30			0.02		
2-Chloronaphthalene	0.66			0.01		
4-Chloro-3-methylphenol	1.30	26 - 103	33	0.02	22 - 147	42
2-Chlorophenol	0.66	25 - 102	50	0.01	23 - 134	40
4-Chlorophenyl phenyl ether	0.66			0.01		
Chrysene	0.66			0.01		
Dibenzo(a,h)anthracene	0.66			0.01		
Dibenzofuran	0.66			0.01		
Di-n-butylphthalate	0.66			0.01		
Di-n-Octylphthalate	0.66			0.01		
1,3-Dichlorobenzene	0.66			0.01		
1,4-Dichlorobenzene	0.66	28 - 104	27	0.01	20 - 124	28
1,2-Dichlorobenzene	0.66			0.01		
3,3'-Dichlorobenzidine	1.30			0.02		
2,4-Dichlorophenol	0.66			0.01		
Diethyl phthalate	0.66			0.01		
2,4-Dimethylphenol	0.66			0.01		
Dimethyl phthalate	0.66			0.01		
4,6-Dinitro-2-methylphenol	3.30			0.05		
2,4-Dinitrophenol	3.30			0.05		
2,4-Dinitrotoluene	0.66	28 - 89	47	0.01	39 - 139	38
2,6-Dinitrotoluene	0.66			0.01		
Di-n-octylphthalate	0.66			0.01		
Fluoranthene	0.66			0.01		
Fluorene	0.66			0.01		

TABLE D-5

Accuracy, Precision, and PQL Limits for Method 8270
143rd CCSQ, Seattle ANGS, Seattle, Washington

	Soil			Groundwater		
	PQL	QC Limits (a)		PQL	QC Limits (a)	
Target Analytes	mg/kg	% Recovery	RPD	mg/l	% Recovery	RPD
Hexachlorobenzene	0.66			0.01		
Hexachlorobutadiene	0.66			0.01		
Hexachlorocyclopentadiene	0.66			0.01		
Hexachloroethane	0.66			0.01		
Indeno(1,2,3-cd)pyrene	0.66			0.01		
Isophorone	0.66			0.01		
2-Methylnaphthalene	0.66			0.01		
2-Methylphenol (o-cresol)	0.66			0.01		
4-Methylphenol (p-cresol)	0.66			0.01		
Naphthalene	0.66			0.01		
2-Nitroaniline	3.30			0.05		
3-Nitroaniline	3.30			0.05		
4-Nitroaniline	1.30			0.02		
Nitrobenzene	0.66			0.01		
2-Nitrophenol	0.66			0.01		
4-Nitrophenol	3.30	11 - 114	50	0.05	D - 132	50
N-Nitroso-di-n-propylamine	0.66	41 - 126	38	0.01	D - 230	38
N-Nitrosodiphenylamine	0.66			0.01		
Pentachlorophenol	3.30	17 - 109	47	0.05	14 - 176	50
Phenanthrene	0.66			0.01		
Phenol	0.66	26 - 90	35	0.01	5 - 112	42
Pyrene	0.66	35 - 142	36	0.01	52 - 115	31
1,2,4-Trichlorobenzene	0.66	38 - 107	23	0.01	44 - 142	28
2,4,5-Trichlorophenol	0.66			0.01		
2,4,6-Trichlorophenol	0.66			0.01		

PQL - Practical Quantitation Limit
LCS - Laboratory Control Sample
QC - Quality Control
RPD - Relative Percent Difference
µg/kg - mircrograms per kilogram
mg/l - milligrams per liter
a - Limits should be viewed as goals and not as a means of accepting or rejecting data.
QC Limits apply to both Matrix Spike and LCS recoveries.

TABLE D-6

Accuracy, Precision, and PQL Limits for Methods 6010/7000
143rd CCSQ, Seattle ANGS, Seattle, Washington

		Soil			Groundwater		
	Method of	PQL	QC Limits (a)		PQL	QC Limits (a)	
Target Analytes	Analysis	mg/kg	% Recovery	RPD	mg/l	% Recovery	RPD
Antimony	6010/Trace-ICP	2	75-125	20	0.025	75-125	20
Arsenic	6010/Trace-ICP	2	75 - 125	20	0.01	75 - 125	20
Beryllium	6010/Trace-ICP	1	75 - 125	20	0.005	75 - 125	20
Cadmium	6010/CLP	1	75 - 125	20	0.005	75 - 125	20
Chromium (total)	6010/CLP	2	75 - 125	20	0.01	75 - 125	20
Copper	6020/200.8	1	75 - 125	20	0.005	75 - 125	20
Lead	6010/Trace-ICP	0.6	75 - 125	20	0.003	75 - 125	20
Mercury	7470/7471	0.1	75 - 125	20	0.0002	75 - 125	20
Nickel	6020/200.8	1	75-125	20	0.005	75-125	20
Selenium	6010/Trace-ICP	1	75 - 125	20	0.005	75 - 125	20
Silver	6020/200.8	1	75 - 125	20	0.005	75 - 125	20
Thallium	6020/200.8	1	75-125	20	0.005	75-125	20
Zinc	6010/Trace-ICP	2	75-125	20	0.02	75-125	20

PQL- Practical Quantitation Limit
LCS - Laboratory Control Sample
QC - Quality Control
RPD - Relative Percent Difference
mg/kg - milligrams per kilogram
mg/l - milligrams per liter
a - Limits should be viewed as goals and not as a means of accepting or rejecting data. QC Limits apply to both Matrix Spike and LCS recoveries.

TABLE D-7

Accuracy, Precision, and PQL Limits for Various Methods for Radionuclides
143rd CCSQ, Seattle ANGS, Seattle, Washington

Target Analytes	Method of Analysis	Soil PQL pCi/g	Soil QC Limits (a) % Recovery	Soil QC Limits (a) RPD	Groundwater PQL pCi/l	Groundwater QC Limits (a) % Recovery	Groundwater QC Limits (a) RPD
Gross Alpha	9310 / SM-7110A	7	70 - 130	30	2	70 - 130	30
Gross Beta	9310 / SM-7110B	7	70 - 130	30	4	70 - 130	30
Radium-226	903.1	0.5	80 - 120	20	0.5	80 - 120	20
Radium 228	904.0	NA	80 - 120	20	2	80 - 120	20

PQL- Practal Quantitation Limit
LCS - Laboratory Control Sample
QC - Quality Control
NA - Not Applicable
RPD - Relative Percent Difference
mg/kg - miligrams per kilogram
pCi/g - picoCuries per gram
pCi/l - picoCuries per liter
a - Limits should be viewed as goals and not as a means of accepting or rejecting data. QC Limits apply to LCS recoveries.

trace metals, and radionuclides. Detection limits for TPH in soil and groundwater are 30 mg/kg and 1 milligram per liter, respectively. Required holding times for soil and water samples are summarized in Table D-8. In some cases, the MTCA Method B cleanup levels are less than the practical quantitation limits for some of the compounds and constituents included in Table D-2. WDOE recognizes this situation and provides guidance regarding adopting practical quantitation limits as cleanup standards (WDOE, 1995).

TABLE D-8

Summary of Sample Holding Times for Water and Soil Samples
143rd CCSQ, Seattle ANGS, Seattle, Washington

Parameter	Holding Time
	Water Samples
VOCs	Analyze within 14 days of collection.
Trace Metals (except Mercury)	Analyze within 6 months of collection.
Mercury	Analyze within 28 days of collection.
TPH	Extract within 14 days of collection and analyze within 40 days of extraction.
SVOCs	Extract within 14 days of collection and analyze within 40 days of extraction.
Radionuclides	Analyze within 6 months of collection.
	Soil Samples
VOCs	Analyze within 14 days of collection.
Trace Metals (except Mercury)	Analyze within 6 months of collection.
Mercury	Analyze within 28 days of collection.
TPH	Extract within 7 days of collection and analyze within 40 days of extraction.
SVOCs	Extract within 14 days of collection and analyze within 40 days of extraction.
Radionuclides	Analyze within 6 months of collection.

1.4.2 Sample Planning for IRP Site 1 - Burial Site

The sampling plans for IRP Site 1 - Burial Site are summarized in the main text of the RI/FS Work Plan.

1.4.3 QC During Field Sampling

Field duplicate samples, and field and trip blanks will be submitted to the analytical laboratory to provide the means to assess the quality of the data resulting from the field sampling program. Field and trip blank samples will be analyzed to check for contamination associated with sampling procedures and/or ambient conditions at the site. Duplicate samples will be submitted using nonindicative sample identifiers to provide a QA check on analytical procedures and results.

QC for soil sample collection will include the following:

- Field duplicate samples will be collected at the frequency of 10 percent of the total number of original samples.
- Equipment rinsate blank samples and field blank samples will be collected at a total frequency of 10 percent of the total number of original samples.
- One trip blank for VOC analysis will be included with each cooler of samples for VOC analysis. The trip blank will be prepared using ASTM Type II water.

QC for groundwater sample collection will include the following:

- Field duplicate samples collected at the frequency of 10 percent of the total number of original samples.
- Equipment rinsate blank samples and field blank samples will be collected at a total frequency of 10 percent of the total number of original samples.
- One trip blank for VOC analysis will be included with each cooler of samples for VOC analysis. The trip blank will be prepared using ASTM Type II water.

Matrix spike samples provide information about the effect of the sample matrix on the analytical methodology. Matrix spike analyses are performed within the analytical laboratory. All matrix spikes are performed in duplicate. Matrix spike/matrix spike duplicates are investigative samples collected at triple the volume for VOCs and double the volume for the remaining analytes. One matrix spike/matrix spike duplicate will be designated for every 20 samples per sample matrix (groundwater and soil).

QC for field measurements (i.e., pH, specific conductance, and turbidity) consists of a pre-measurement calibration and a post-measurement verification using standard reference solutions in accordance with the manufacturer's recommendations. These procedures will be performed at least once per day or more often as necessary. QC for field measurement of temperature will include measurement with a second measuring device.

Holding times for water and soil samples are summarized in Table D-9. Holding times are defined as the maximum length of time that samples may be held before the completion of analytical protocols. All samples will be chilled in a temperature range between 2° and 4° C and will be maintained at that temperature through transport and subsequent storage at the analytical laboratory. Samples will not be retained on site over 24 hours unless prior approval is received from the ANG/CEVR Project/Site Manager.

1.4.3.1 Groundwater Sample Preservation

Samples collected for VOC analysis will be preserved with no more than two drops of a 1:1 solution of hydrochloric acid per 40-milliliter glass VOC vial. The vial will have a Teflon-lined septa within the lid. VOC samples will be stored in an ice chest. Samples collected for TPH and SVOC analysis will each be stored in separate, 1-liter, amber glass bottles with Teflon-lined lids. Samples collected for trace metal analysis will be preserved in a 1-liter, polyethylene container and will be preserved using a nitric acid solution to a pH of less than 2 units. Samples collected for radionuclide analysis will be collected in 1-liter plastic bottles.

1.4.3.2 Soil Sample Preservation

All soil samples submitted for laboratory analysis will be contained in brass sleeves. Immediately upon removal from the split-spoon sampler, the ends of the filled brass sleeves will be covered first with Teflon (a moisture barrier), aluminum foil, and then with a fitted plastic cap. Samples will then be placed in individual, self-sealing bags and stored in an ice chest with enough ice to maintain samples at a temperature of less than 4° C.

1.5 Accuracy, Precision, and Sensitivity of Analysis

The accuracy, precision, and sensitivity of laboratory analytical data must satisfy the QC acceptance criteria of the analytical protocols. Detection limits required in aqueous and solid matrices are shown in Tables D-3 through D-7.

TABLE D-9

Quality Assurance Objectives for Accuracy of Surrogate Spike Samples
143rd CCSQ, Seattle ANGS, Seattle, Washington

Method/Compound	Surrogate Compound	Water Percent Recovery Limits	Low/Medium Soil Percent Recovery Limits
VOC 8010/8020	a,a,a-Trifluorotoluene	70-120	65-130
VOC 8010/8020	Bromochloromethane	65-125	55-135
VOC 8010/8020	4-Bromofluorobenzene	60-120	50-130
VOC 8260	Bromofluorobenzene	86-115	74-121
VOC 8260	1,2-Dichloroethane-d	76-114	70-121
VOC 8260	Toluene-d8	88-110	81-117
SVOC8270	Nitrobenzene-d	35-114	23-120
SVOC8270	2-Fluorobiphenyl-d	43-116	30-115
SVOC8270	p-Terphenyl-d	33-141	18-137
SVOC8270	Phenol-d	10-94	24-113
SVOC8270	2-Fluorophenol	21-100	25-121
SVOC8270	2,4,6-Tribromophenol	10-123	19-122
PCBs 8080	TCMX	60-150	60-150
PCBs 8080	DCB	60-150	60-150

VOC = volatile organic compounds
SVOC = semivolatile organic compounds
PCBs = polychlorinated biphenyls
TCMX = tetrachloro-m-xylene
DCB = decachlorobiphenyl
Note: These limits are for advisory purposes only. They are not used to determine if a sample should be reanalyzed.

1.5.1 QA Objective for Accuracy

Analytical accuracy is calculated by expressing, as a percentage, the recovery of an analyte that has been added to the sample (or standard matrix) at a known concentration before analysis and is expressed in the following formula:

$$\text{Percent Recovery} = \frac{(SSR-SR)}{SA} \times 100$$

Where
SSR = Spiked Sample Result;
SR = Sample Result; and
SA = Spike Added.

The spiked concentration will be specified by laboratory QC requirements or may be determined relative to the background concentrations observed in the nonspiked sample. In the latter case, the spiked concentration should be significantly higher (two to five times higher) than the background concentration to permit a reliable recovery calculation.

1.5.1.1 Inorganic Analysis

Analytical accuracy for trace metals is measured from analysis of a laboratory control standard and a spiked sample. Recovery values outside of the QC limits for a laboratory control sample will trigger corrective action. Recovery values for spiked samples are advisory only.

1.5.1.2 Organic Analysis

For volatile organic analysis Gas Chromatography (GC) and GC/Mass Spectrometry, analytical accuracy is obtained from the surrogate recovery measured in each sample and blank or from the analysis of samples or blanks spiked with a select number of target analytes.

The QA objectives for surrogate recovery are summarized in Table D-9. The objectives for matrix spike recovery are summarized in Tables D-3 through D-7. Failure to achieve these recoveries will trigger corrective action. The recovery values for surrogate and target analytes in field sample analyses are advisory for routine laboratory analytical services.

1.5.2 QA Objective for Precision

Analytical precision is calculated by expressing, as a percentage, the difference between the results of analysis of duplicate samples relative to the average of those results for a given analyte. Precision can be expressed by the following formula:

$$RPD = \frac{(SPL1 - SPL2)}{\text{Mean of SPL1 and SPL2}} \times 100$$

Where

RPD = Relative Percent Difference;

SPL1 = First sample value (original); and

SPL2 = Second sample value (duplicate).

1.5.3 Completeness, Representativeness, and Comparability

Completeness is a measure of the relative number of analytical data points that meet all the acceptance criteria for accuracy, precision, and any other criterion required by the specific analytical methods used. The percent of completeness for analytical data can be expressed by the following formula:

$$\text{Percent Completeness} = (V/T) \times 100$$

Where

V = Number of Valid Data Points; and

T = Total Number of Data Points.

The QA objective for analytical data completeness for the RI/FS is 90 percent. The ability to meet or exceed this objective depends on the nature of the samples submitted for analysis.

The sampling plan has been designed to provide data representative of site conditions. During development of the sampling methodologies, consideration was given to past waste disposal practices, existing analytical data, physical setting, and constraints inherent to the program. The extent to which existing and planned analytical data will be comparable depends on the similarity of sampling and analytical methods. The procedures used to collect data for the RI, as documented in this QAPP, are expected to provide comparable analytical data. The data collected during the RI may not be directly comparable to existing data because of differences in the procedures and QA objectives.

1.6 Field Measurements

Most data collected during the RI/FS will be based on laboratory analysis of samples collected at the investigation site. There are certain data, such as groundwater parameters (i.e., specific conductance, temperature, turbidity and pH) that will be collected and directly recorded in the field. The primary QA objectives for field activities should verify that QC checks are performed, measurements were obtained to the degree of accuracy consistent with their intended use, and documentation has been generated to verify adherence to required measurement procedures.

Surveying and mapping at Seattle ANGS will be conducted to provide a common frame of reference for RI/FS activities. Surveying will be performed by a surveyor registered in the State of Washington. Surveying of monitoring wells, surface soil samples, soil borings, and Geoprobe™/Hydropunch™ sample locations will be completed to an accuracy of ± 0.1 foot horizontally and ± 0.01 foot vertically. All bench marks used will be permanent marker(s) that will be tied to NGVD Mean Sea Level using either a USCGS or USGS survey marker.

The recording of field data will follow standard reporting procedures as follows:

- Soil sampling depths will be reported to the nearest 0.1 foot.
- All temperatures will be recorded to the nearest 0.1° C
- pH will be reported to 0.1 standard units.
- Depth to groundwater in monitoring wells will be reported to the nearest 0.01 foot.
- PID measurements will be reported to the nearest 0.1 ppm.
- Specific conductance will be reported in microsiemens and will be reported with the full number of units in the instrument range scale used for the measurement.
- Turbidity will be reported in nephelometric turbidity units and will be reported with the full number of units in the instrument range scale used for the measurement.

1.7 Sampling Procedures

Procedures used for collecting soil and groundwater samples will follow Standard Operating Procedures developed for ERM's IRP program work and will conform to ANG/CEVR investigation protocols. The Standard Operating Procedures are included in ERM's IRP Program Quality Assurance Program Plan (IRP QAPP, Appendix B; ERM, 1995). The Project/Site Manager is responsible for ensuring that samples are collected with properly decontaminated equipment and contained in properly cleaned sample containers. The steps required for sample control and identification, data recording, and chain-of-custody documentation are included in the IRP QAPP.

Prior to the beginning of each type of sampling event, the Project/Site Manager will meet with the assigned sampling personnel and review the purpose and objectives of the event. This meeting will provide final clarification of the sampling event details. Topics of review and discussion will include the following: sampling locations; types of samples to be collected; number of samples to be collected; sample identifiers; compounds or constituents to be analyzed; sampling procedures; sampling equipment decontamination procedures; and chain-of-custody documentation requirements.

Equipment decontamination is an integral part of the data collection and QA process. The implementation of proper decontamination practices and procedures will begin in the field prior to the use of sample collection equipment. All field sampling equipment will be decontaminated before and after use, in accordance with ANG/CEVR protocols. Wash water and other fluids created during decontamination will be containerized and will be disposed of properly.

1.7.1 Geoprobe™/Hydropunch™ Sampling

Groundwater samples will be collected using a Hydropunch™ groundwater sampling tube comprised of a stainless steel drive point, perforated section of stainless steel pipe for sample intake, a stainless steel and teflon sample chamber, and an adapter to attach the unit to a Geoprobe™ rod. The unit is pushed through the soil to the desired sampling depth. The sampler is then retracted allowing groundwater to flow through the screen and into the sample chamber. Once the chamber is filled, the Hydropunch™ sampling tube is pulled toward the surface. Upon retrieval at the surface, the drive cone is removed and a sample discharge device is inserted for transferring the groundwater sample to the sample container. Equipment used during Geoprobe™/Hydropunch™ sampling will be decontaminated between sampling locations as specified in the RI/FS Work Plan.

1.7.2 Soil and Sediment Sampling

Subsurface soil samples will be collected using a split-spoon sampler and hollow-stem auger drill rig. The split-spoon sampler will be constructed of stainless-steel and equipped with brass sampling tubes. Surface soil samples will be collected using a hand-auger unit equipped with brass sampling tubes. Storm sewer sediment samples will be collected using a stainless steel trowel or scoop. Equipment used during soil and sediment sampling will be decontaminated between sampling locations as specified in the RI/FS Work Plan.

1.7.3 Groundwater Sampling

The following procedures will be utilized during groundwater sampling activities at new and existing monitoring wells:

- Groundwater samples will not be collected until at least 2 days after the development of new monitoring wells to allow water in the wells to reach equilibrium.

- Immediately prior to collecting a sample, the static water level will be measured with reference to the monitoring well's measuring point and will be recorded in the field notebook.

- Whenever feasible, monitoring wells will be sampled in order of increasing level concentration of contaminants, based on analysis of samples collected during previous sampling rounds.

- Prior to collecting a sample, the volume of water in the screen and monitoring well casing will be purged three times. If the monitoring well yield is sufficient, additional well volumes may be removed until the temperature, specific conductance, turbidity, and pH of the monitoring well have stabilized. Monitoring wells that recharge extremely slow will be purged dry, allowed to recharge, and purged again. The amount of fluid purged will be measured and recorded.

- Monitoring wells will be sampled directly from the pump discharge. A decontaminated length of tubing will be used to collect the sample from the pump's discharge port.

- All sampling equipment will be kept off contaminated soil to prevent cross-contamination of the samples (e.g., equipment will be placed on polyethylene plastic sheeting).

1.8 Sample Chain-of-Custody Procedures

Sample chain-of-custody procedures require that possession and handling of all samples be documented from the moment of its collection through the time of completion of laboratory analyses. The Chain-of-Custody Record must clearly reflect the movement of the sample through the sample handling and transport process to ensure that proper custody has been maintained and that the sample has not been tampered with in any way. A sample is judged to be in proper custody when at least one of the following criteria has been met:

- The sample is in one's actual physical possession;
- The sample is in one's clear field of view after being in one's physical possession;
- The sample is in one's physical possession and is then locked up in a secure container so that no one can tamper with it; or
- The sample is kept in a secured area that can be accessed by authorized personnel only.

1.8.1 Sample Labels

All samples will be identified with a label attached directly to the container. Sample label information will be completed using waterproof black ink and will contain the following information:

- Sample number;
- Time and date of collection;
- Installation name;
- Parameters to be analyzed;
- Preservative (if any);
- Sample identifier; and
- Sampler's initials.

1.8.2 Chain-of-Custody Record

To maintain a record of sample collection, transfer between sample custodians, shipment, and receipt by the laboratory, a Chain-of-Custody Record will be filled out for all samples collected for laboratory analysis. Each time the samples are transferred, the signatures of the person relinquishing and receiving the samples, as well as the date and time of transfer, will be documented.

1.8.3 Transfer of Custody and Shipment

Prior to the shipment of samples, the Chain-of-Custody Record will be signed and dated by a member of the field team who has verified that those samples indicated on the Chain-of-Custody Record are indeed being shipped. A copy of ERM's standard Chain-of-Custody Record is shown on Figure D-1. After packaging has been completed and the samples are locked within the cooler, signed and dated custody seals will be placed over the lid edge.

All samples will be shipped by air courier, such as Federal Express, or hand delivered by ERM personnel to the analytical laboratory. Samples will be transported, generally each day, by field personnel from the Station to the courier location for subsequent shipment to the laboratory. Upon receipt of the samples at the laboratory, the receiver will complete the transfer by dating and signing the Chain-of-Custody Record. An acceptable alternative is to enter the airbill number and shipping data into the appropriate signature/date block. A copy of the airbill is to be kept with the field copy of the Chain-of-Custody Record to reflect specific shipping information.

1.8.4 Laboratory Chain-of-Custody Procedures

The following describes laboratory chain-of-custody procedures associated with sample receipt, storage, preparation, analysis, and general security.

1.8.4.1 Sample Receipt

Sample receipt procedures are discussed below.

- Upon receipt, the sample custodian will inspect sample containers for integrity. The presence of leaking or broken containers will be noted on the Chain-of-Custody Record. The sample custodian will sign the Chain-of-Custody Record with the date and time of receipt, thus assuming custody of the samples.

Date________ Weather________________________ Page ____ of ____

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Chain of Custody Record

Job #	Collection	GC	GC/MS	Inorg	Other		Remarks
Job Location							
Sampler (signature)							
Printed name							
Lab Report Recipient							
Telephone No.							
Receiving Lab							
Address							

Sample ID#	Time	W=water S=soil	C=comp G=grab	Volume	Container type	ICED	Preservative	Sampling method	TPH-Extraction	BTEX/Total Fuel HCs	601 / 8010 Halocarbons	602 / 8020 Aromatics	604 / 8040 Phenols	608 / 8080 Pest/PCBs	624-8240 Purgeables	625-8270 BNAs & Pest (SVs)	Dioxins	Metals	Wet Chemistry	Number of Containers	Remarks

Precautions: Conc: ☐ Lo ☐ Med ☐ Hi | Ship Via | Total Number of Containers:

Sample Relinquished By	Date	Time	Received By	Date	Time	Reason for Transfer (List Shipping Bill Number)
Company			Company			
Company			Company			

LABORATORY— Please Complete ☐ Samples intact ☐ Samples at 4°C ☐ Samples not leaking ☐ # of containers matches C-of-C ☐ Container tags match C-of-C ☐ Cooler seals intact

Lab sample custodian Signature Date Time | **Sample Disposition** ☐ Return to Site ☐ Discard ☐ Hold____ days

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FIGURE D-1

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- The information on the Chain-of-Custody Record will be compared with the information on the sample labels to verify the exact sample identity. Any inconsistencies will be immediately resolved with the field sampling representative before sample analysis proceeds.

- Samples will be moved to a locked sample storage refrigerator for storage prior to analysis. The storage location will be recorded on the Chain-of-Custody Record or Laboratory Tracking Form to ensure continuity of sample tracking.

- The sample custodian will retain the original Chain-of-Custody Record and will provide copies to each laboratory section manager and one to the laboratory's sample master log.

- The sample custodian will alert the appropriate section managers and analysts of any analyses requiring immediate attention because of short holding times.

1.8.4.2 Sample Storage

Samples requiring refrigeration will be maintained in a locked storage refrigerator which will be kept at temperatures ranging from 2° to 4° C. Analytical laboratory personnel will request samples for analysis from the sample custodian and the formal transfer action, including date and signatures, will be recorded on the Chain-of-Custody Record. The analyst will then be the custodian of the sample during analysis.

1.8.4.3 Data Recording

Raw data is calculated or reduced into reportable values in three ways at the laboratory: manually, by an external computer program, and by a data system that collects the raw data. Individual laboratories have specific data recording and data management standard operating procedures. In general, data collected on an instrument's data system are transferred electronically into the laboratory's data acquisition program. Data acquisition transfers data into the laboratory information management system for routine final reporting and is also used for generation of analytical data reports. All formulae used to calculate reported values are those specified by the analytical method and are included in internal laboratory standard operating procedures.

1.9 Documentation Procedures

Documentation procedures for sample identification and field logs are discussed below. Procedures for document corrections are also discussed.

1.9.1 Sample Identification

A standardized numbering system will be used to identify all samples taken from water and soil sampling activities. The numbering system provides a tracking procedure to ensure accurate data retrieval of all samples taken. A listing of the sample identification numbers will be maintained by the field supervisor, who will be responsible for enforcing the use of the standardized numbering system during all sampling activities.

The standard sample identifiers for field samples are coded as follows:

- Sample identifiers for original soil samples will include the site number, soil boring number, and sample depth. For example, SB1-1-5 represents a sample collected at a depth of 5 feet bgs from soil boring SB-1.

- Sample identifiers for original groundwater samples will include the monitoring well number, and the quarterly sampling round. For example, MW01-96-1 represents a groundwater sample collected during the first round of quarterly sampling in 1996 from monitoring well MW-1.

Field QA/QC sample identifiers for soil will be as follows:

- Sample identifiers for trip blanks will be as follows: TB-date-#. For example, TB-051097-1 represents the first trip blank collected on May 10, 1997.

- Sample identifiers for field duplicates will be the same as the original sample but followed by an asterix (*).

- Sample identifiers for rinsate blanks and field blanks will be the same as the boring identifier at which the blank was prepared but followed by an asterix (*).

The QA/QC sample identifiers for groundwater will be as follows:

- Sample identifiers for groundwater trip blanks will be the same as those for soil.
- Sample identifiers for rinsate and field blanks will be the same as the monitoring well at which the blank was prepared followed by an asterix (*).
- Sample identifiers for groundwater duplicate samples will be the same as those described for soil.

1.9.2 Field Logs

All data collection activities performed at a site will be documented using waterproof, indelible black ink, in a field notebook or on Chain-of-Custody Records. Field notebooks will be bound, waterproof, and assigned to individual field personnel for use during the duration of their field activities. Entries will be as detailed and as descriptive as possible so that a particular situation can be recalled without reliance solely on the sampler's memory. All field log entries will be dated and signed by the person making them.

Depending on field activities, the Project/Site Manager may designate a member of the field team to photocopy, at the end of each day, all field logs (notebook pages and standard forms) generated during that day. Copies will be given to the Project/Site Manager. If implemented, at the completion of a work shift, copies of all field logs, notebook pages, and standard forms will be returned to the Project/Site Manager for subsequent entry into project files.

The Project/Site Manager will maintain a separate Site Log which will summarize daily field activities, outside visitors, communications, sample shipments, and equipment assignments. This log will become a part of permanent project files.

1.9.3 Corrections to Documentation

If an incorrect entry is made in any type of data document, the incorrect data will be lined out with a single line, the correct information entered, and the correction initialed and dated by the person making the correction. Like original entries, corrections will be made in indelible black ink.

1.9.4 Final Evidence File Documentation

Records will be kept by the Project/Site Manager to document the QA/QC activities and to provide support for possible evidential proceedings. The following outline of project file requirements applies to project activities:

Communications

- Internal
- External
- QA/QC
- Procedures
- Chain-of-Custody Documentation
- Audit Reports
- Laboratory QA Reports
- Deviation Notification Forms
- Nonconformance/Corrective Action Reports

Technical Information

- Analytical Data
- Field Data
- Field Logbooks
- Graphic Resources
- Data Quality Acceptance
- Calculations/Evaluations
- Regulatory Compliance

Project Management

- Project Schedule
- Budget

- Site Database Information

Health and Safety

- Plans/Procedures
- Audit Reports

Documents

- Plans
- Reports
- Relevant Publications

ERM will maintain all evidential file documentation using its internal project file system. Upon completion of the project, all records will be archived. Copies of file documentation will be provided to ANG/CEVR upon request. The Project/Site Manager will ensure that all records, including QA/QC records, are properly stored and retrievable.

1.10 Calibration Procedures and Frequency

The following sections summarize calibration procedures for field and laboratory equipment.

1.10.1 Field Equipment

The analytical and health and safety screening instruments that may be used in the field during the RI/FS are:

- PID;
- Conductivity Meter;
- pH Meter;
- Turbidity Meter; and
- Temperature Meter.

The instruments will be calibrated according to manufacturers' specifications before and after each field use, or as otherwise required.

Where necessary, instruments will be calibrated each day during field use.

1.10.1.1 Photoionization Detector

Calibration of the PID will be performed at the start of each day using a standard calibration gas. Additional calibrations will be made if the unit experiences abnormal perturbations or readings become erratic. Results of the calibration will be recorded in the field notebook in indelible ink. Calibration procedures will follow manufacturer's instructions.

1.10.1.2 Conductivity Meter

Calibration is performed at the start of each sampling day using a standard solution of potassium chloride. The meter will be adjusted to read the value of the standard. The meter must read within 10 percent of the standard to be considered in control and should read within 5 percent (7 percent is considered a warning level). If the calibration indicates the meter readings are out of the control limits, a backup unit should be employed. If a backup unit is not available, the data will be flagged to note the percent difference between the meter and the standard calibration solution. Readings from conductivity meters lacking calibration adjustments are normally stable; thus, calibration checks are usually limited to the beginning and end of the sampling day.

1.10.1.3 pH Meter

Calibration is performed at the start of each sampling day using National Bureau of Standards traceable buffer solutions which bracket the pH range expected in the samples. The pH Meter will be adjusted to read the value of the standard. The meter is checked during the sampling day, using at least one standard, at a frequency which results in little or no calibration adjustment. If the reading varies more than one-tenth of a unit between calibration checks, the frequency of the checks must be increased.

1.10.1.4 Turbidity Meter

Calibration is performed at the start of each sampling day using a formazin solution. The turbidity meter will be adjusted to read the value of the standard. The meter is checked during the sampling day, using at least one standard, at a frequency which results in little or no calibration adjustment. If the reading varies more than one-tenth of a unit between calibration checks, the frequency of the checks must be increased.

1.10.1.5 Temperature Meter

Temperature is measured by either using a thermostat built into the specific conductance meter or a separate thermometer unit. In all cases, the readings will be checked at least once per field trip using a quality-grade (preferably National Bureau of Standards traceable) thermometer. The frequency of calibration, however, is a minimum; should the unit experience erratic or out-of-tolerance readings, additional checks will be performed.

1.10.2 Laboratory Equipment

Before any laboratory instrument is used as a measuring device, the instrument response to known reference materials must be determined. The manner in which various instruments are calibrated is dependent on the particular type of instrument and its intended use. All sample measurements will be made within the calibrated range of the instrument.

Laboratory calibrations typically consist of two types, initial calibration and continuing calibration. Initial calibration procedures establish the calibration range of the instrument and determine instrument response over that range. Typically, three to five analyte concentrations are used to establish instrument response over a concentration range. Continuing calibration usually includes measurement of the instrument response to one or more calibration standards and requires instrument response to compare with certain limits (e.g., ± 10 percent) of the initial measured instrument response.

Specific laboratory instrument calibration procedures for various instruments are described in detail in the Laboratory Quality Assurance Project Plan for the analytical laboratory selected to perform the analyses.

1.11 Analytical Procedures

The following sections summarize the analytical procedures for field activities and the laboratory.

1.11.1 Field Parameters

As part of the analytical protocol for groundwater samples, several parameters will be tested in the field. All aqueous samples will be tested for specific conductance, temperature, and pH. Initial samples collected at SI monitoring wells will also be field tested for turbidity. At each sampling location, a groundwater sample will be collected in a clean sample container for field parameters measurement.

1.11.2 Laboratory Methods

Groundwater and soil samples collected will be analyzed using the analytical methods specified in the RI/FS Work Plan.

1.12 Internal QC Check Procedures

The following sections summarize internal QC check procedures for laboratory analysis and field measurements.

1.12.1 Routine Analytical Services

Internal QC procedures for routine analytical services are specified in the EPA's method descriptions. These specifications include the types of QC checks required (sample spikes, surrogate spikes, reference samples, controls, and blanks), the frequency of each audit, the compounds to be used for sample and surrogate spikes, and QC acceptance criteria for these checks.

1.12.2 Field Measures

QC procedures for field measurements are linked to checking the reproducibility of the measurements by obtaining multiple readings and by calibrating the instruments (when appropriate). QC of field sampling will involve collecting field duplicates and blanks in accordance with the applicable procedures described in this QAPP.

1.13 Data Reduction, Validation, and Reporting

The following sections summarize reduction, validation, and reporting procedures for field, technical, and laboratory data.

1.13.1 Field and Technical Data

The field and technical (nonlaboratory) data that will be collected can generally be characterized as either objective or subjective data. Objective data include all direct measurements, such as field screening/analytical parameters and water level measurements. Subjective data include activity descriptions and observations.

1.13.1.1 Field and Technical Data Reduction

As described in previous sections, all field data will be recorded by field personnel in bound field notebooks and on standard forms. For example, during drilling activities, the field team member supervising a rig will keep a chronological log of drilling activities, a vertical descriptive log of lithologies encountered, other pertinent drilling information (i.e., staining, odors, field screening, working conditions, and water levels) in his/her bound notebook. The Project/Site Manager may choose to appoint a team member to photocopy all field logs (including notebook pages and standard forms) generated in a given field day. Copies will be given to the Project/Site Manager who will maintain a field log file. At the direction of the Project/Site Manager, copies of all field logs, notebook pages, and standard forms will be returned to the field office for entry into project files.

After checking the validity of data in field notes and on standard forms, the Project/Site Manager will be responsible for entering pertinent data into data files. Where appropriate, the data files will be set up for direct input into the project database. Subjective data will be filed as hard copies for later review by the Project/Site Manager and for incorporation into technical reports as appropriate.

1.13.1.2 Field and Technical Data Validation

Validation of objective field and technical data will be performed at two different levels. On the first level, data will be validated at the time of collection by following standard procedures and QC checks. At the second level, data will be validated by the Project/Site Manager, who will review the data to ensure that the correct codes and units have been included. After data reduction into tabular format or the project database, the Project/Site Manager will review data sets for anomalous values. Any inconsistencies or anomalies discovered will be resolved immediately, if possible, by seeking clarification from field personnel responsible for collecting the data. Subjective field and technical data will be validated by the Program Manager, who will review field reports for reasonableness and completeness. In addition, random checks of sampling and field conditions will be made by the

Project/Site Manager who will check recorded data at that time to confirm the recorded observations. Whenever possible, peer review will also be incorporated into the data validation process, particularly for subjective data, to maximize the consistency among field personnel. For example, during drilling activities, the Project/Site Manager will schedule periodic reviews of archived lithologic samples to ensure that proper lithologic descriptions and codes have been consistently applied by field personnel.

1.13.2 Laboratory Data

As described earlier, all analytical data will be recorded in three ways: manually; an external computer program; and a data system that collects the raw data. All data collected on an instrument's data system are transferred electronically into the laboratory's data acquisition program. Data acquisition transfers data into the laboratory information management system for routine final reporting and is also used for generation of analytical data reports. Copies of strip-chart outputs (e.g., chromatograms) will be maintained on file at the laboratory.

1.13.2.1 Laboratory Data Reduction

At the completion of a set of analyses, all calculations will be completed and checked by the analyst. The associated QC data (blanks, blank spikes, duplicates) are entered onto QC charts and are verified to be within control limits. If all data are acceptable, the data are entered into the laboratory computer system, and data summaries (including raw data) are submitted to the laboratory section manager for review. This is the procedure for all analytical data. After approval, data are subsequently entered into the project database format.

1.13.2.2 Laboratory Data Validation

In addition to the data review performed by the analysts and the appropriate laboratory section manager, an external organization to the one that generated the data will validate the analytical data. All analytical data will be reviewed and assessed by the RI/FS Project/Site Manager, using a step-by-step approach. Approximately 10 percent of the data generated by the laboratory (original samples only) will be subjected to validation against DQOs using EPA validation procedures for specified analytes.

1.13.2.3 Laboratory Data Reporting

Laboratory analytical results will be reported as soon as results are available and will follow EPA requirements in order to provide defensible evidence files. The standard laboratory data reports for organic compound analysis will consist of a transmittal letter and the following:

- A cover page describing data qualifiers, sample collection, extraction and analysis dates, and a description of any technical problems encountered with the analysis.
- Sample data including detection limits.
- Summary of QC data, including laboratory blanks, matrix spike/matrix spike duplicates, and surrogate recovery results.

The standard laboratory data reports for inorganic constituent analysis will consist of a transmittal letter and the following:

- A cover page describing data qualifiers, sample receipt, digestion and analysis dates, and a description of any technical problems encountered with the analysis.
- Sample data including detection limits.
- Summary of QC data, including laboratory blanks, and matrix spike/matrix spike duplicate results.

1.14 Performance and System Audits

Audits may consist of two types, system and performance audits. The purpose of a system audit is to determine whether appropriate project systems are in place. Performance audits are used to indicate whether those systems are functioning properly. Audits will be conducted by the project QA Officer or technician as tasked by the Project/Site Manager to verify the existence of an effective QC system. Additionally, the audit will evaluate the level of compliance of that system in terms of adherence to QC measures, standards, records, and project documentation and control.

1.14.1 Project System Audits

The QA/QC Officer will periodically, on an unannounced basis, call for a system audit. The Project/Site Manager will respond by submitting the QAPP. The audit will be performed by the QA/QC Officer or an auditor named by the Project/Site Manager and the QA/QC Officer. The auditor will then determine whether the QAPP is in place and whether the reviews called for by the QAPP have been performed. Results of project audits will be reported to the Project/Site Manager and Program Manager.

1.14.2 Technical Performance Audits

Technical performance audits will be conducted by the project QA manager on an ongoing basis during the project, as field data are generated, reduced, and analyzed. All numerical analyses, including manual calculations, mapping, and computer support activities, will be documented and subject to performance audits in the form of QC procedural reviews, mathematical reanalysis, and peer review. Technical peer review is the responsibility of the Project/Site Manager. All records of numerical analyses will be legible, reproduction quality, and complete enough to permit logical reconstruction by a qualified objective reviewer.

1.14.3 Field Audits

A field performance audit will be conducted during each phase of the investigation and will include field sampling and associated sample handling and decontamination techniques. The purpose of the field audit is to ensure that proper methods and protocols detailed in this QAPP are consistently practiced in the field.

Audits will be performed using tailored checklists prepared by the QA/QC Officer. The requirements and audit questions to be developed will be as specific as possible and will focus on significant investigation techniques. Checklists are encouraged to be completed to the maximum extent possible to give a complete picture of field techniques using a structured approach.

Field operation records will be reviewed to verify that field-related activities were performed in accordance with appropriate project procedures. Items reviewed will include, but are not limited to, field equipment calibration records, daily field logs, and chain-of-custody documentation.

Upon audit completion, an audit report containing observations, findings, and recommended corrective actions will be submitted to the Project/Site Manager and the Program Manager.

1.14.4 Laboratory Audits

The laboratory QA manager has responsibility for monitoring the internal QA program. The contractor will verify that standardized QA programs are in effect to provide objective oversight of laboratory procedures. Additionally, copies of internal QA reports will be requested to ensure that standards of quality performance are in effect.

1.15 Preventive Maintenance

Proper preventive maintenance of field and laboratory equipment is an essential element in a successful field investigation. Implementation of standard preventive maintenance routines serves to eliminate surprise equipment failures and subsequent stand-by time.

1.15.1 Field Equipment

Field equipment will be properly calibrated, charged, and in good working condition before the beginning of each working day. Manufacturers' specifications define the required equipment checks for each type of field equipment used. Nonoperational field equipment will be removed from service and a replacement will be performed immediately. Significant repairs to field equipment will not be performed in the field.

All field instruments will be properly protected during the field investigation against inclement weather. Each instrument is specially designed to maintain its operating integrity during variable temperature ranges that are representative ranges that will be encountered during working conditions. At the end of each working day, all field equipment will be taken out of the field and placed in a cool, dry room for overnight storage.

All subcontractor equipment (e.g., drill rigs) will arrive at the site in proper working condition each day. All lubricating and hydraulic motor oils will be checked by the subcontractor before the start of each work day to ensure all fluid reservoirs are full and there are no leaks. Before the start of each work day, the Project/Site Manager will also inspect all equipment for fluid leaks. If a leak is detected, the equipment will be removed from service for repair or replacement.

1.15.2 Laboratory Equipment

The ability to generate valid analytical data requires that all analytical instrumentation be properly maintained. The selected laboratory should maintain full service contracts on all major instruments. These service contracts will not only provide routine preventive maintenance, but will provide emergency repair service to ensure responsive support to the project requirements.

1.15.2.1 Instrument Maintenance Logbooks

Each analytical instrument is assigned a specific instrument logbook. All maintenance activities are recorded in the instrument log. The information entered in the instrument log will include the following:

- Date of service;
- Person performing service;
- Type of service performed and reason for service;
- Replacement parts installed (if appropriate); and
- Other information, as required.

1.16 Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completeness

The QA objectives for precision, accuracy, and completeness were discussed in Section 4.5. This section will discuss the routine procedures used for assessing those criteria.

The initial responsibility to monitor the quality of an analytical system lies with the analyst. The analyst will verify that all QC procedures are followed and the results of analysis of QC samples are within acceptance criteria. If acceptance criteria limits are exceeded, this must be described in the analytical report case narrative. This requires that the analyst assess the correctness of the following items, as appropriate:

- Initial calibration;

- Calibration verification;
- Method blank result;
- Duplicate analysis;
- Laboratory control standard; and
- Spiked sample result.

1.17 Corrective Action Protocols

ERM's QA/QC Officer and audit team will prepare a formal report of all audit proceedings. The programmatic impact of a negative finding, such as failure to use an appropriate procedure, will be determined by the QA/QC Officer or lead auditor and reported to the project management staff. A corrective action plan and implementation schedule will be required, and the Project/Site Manager will be responsible for ensuring that immediate action to correct the nonconformance has been initiated. The Project/Site Manager will be responsible for ensuring the successful implementation of the corrective action plan and ensuring that no additional work that is dependent on the nonconforming action is performed until the nonconformance is corrected. Corrective actions may include reanalyzing samples, if holding times permit, resampling, and evaluating and amending sampling and analytical processes.

The Project/Site Manager will be responsible for ensuring that the corrective action adequately addresses the nonconformance. The QA/QC Officer will ensure that corrective actions for nonconformance are implemented by:

- Evaluating all reported nonconformances;
- Controlling additional work on nonconforming items;
- Maintaining the log of nonconformances; and
- Ensuring that nonconformance and corrective action reports are included in the site documentation files.

Following implementation of satisfactory corrective action, the QA/QC Officer will conduct sufficient follow-up activities to verify the corrective action. Such confirmation will be documented, along with any other recommendations, in a formal close-out of the audit. The close-out report will be distributed to all appropriate project management personnel.

1.17.1 Field Corrective Action

The initial responsibility for monitoring the quality of field measurements and observations lies with field personnel. The Project/Site Manager is responsible for verifying that all QC procedures are being followed. This requires that the Project/Site Manager assess the correctness of field methods and the ability to meet QA objectives. If a problem occurs that might jeopardize the integrity of the project or cause some specific QA objective not to be met, it is the responsibility of all field project staff to report all suspected nonconformances by initiating a nonconformance report and submitting it to the Project/Site Manager.

The Project/Site Manager will submit a copy of the nonconformance report to the QA/QC Officer for a formal investigation. An appropriate corrective action will then be decided upon and implemented. The Project/Site Manager will document the problem, the corrective action, and the results using the corrective action report shown on Figure D-2. Copies of the documentation report will be provided to the Project/Site Manager and the QA/QC Officer.

1.17.2 Laboratory Corrective Action

The initial responsibility to monitor the quality of an analytical system lies with the analyst. In this regard, the analyst will verify that all QC procedures are followed and that the results of analysis of QC samples are within acceptance criteria. This requires that the analyst assess the correctness of all of the following items, where appropriate:

- Sample preparation procedures;
- Initial calibration;
- Calibration verification;
- Method blank result; and
- Laboratory control standards.

If this assessment reveals that any of the QC acceptance criteria have not been met, as defined by the Laboratory QAPP or EPA method standards, the analyst must immediately assess the analytical system to

Nonconformance and Corrective Action Report

Date: ___________

ERM-West Project Number: _____

SUBMITTAL

To: Project Director
QA/QC Officer

Description of Nonconformance and Cause:

____

____

____

Proposed Corrective Action:

____

____

____

Submitted By:____________________ Location:____________________

Approved By:____________________ Date: ____________________

CORRECTIVE ACTION (by Project Manager or Designee):

____

____

____

Implementation by Action assigned to:

Actual Corrective Action:

Implementation verbally approved by QA Officer on __________
(date)

Action implemented on __________
(date)

____
(Signature)

VERIFICATION (by QA/QC Officer of Designee)

Corrective Action implementation reviewed and Work Inspected by:

on__________

Corrective Action Verified by on______________

Figure D-2
Nonconformance and Corrective Action Report

correct the problem. The analyst notifies his/her supervisor, section leader, or QA coordinator of the problem, and, if possible, identifies the potential cause(s) and makes appropriate corrective action recommendations.

The identification of the corrective action obviously depends on the nature of the problem. For example, if a continuing calibration verification is determined to be out of process control, the corrective action may require recalibration of the analytical system and reanalysis of all samples since the last acceptable continuing calibration standard.

Sample-related QC samples (e.g., matrix spikes and matrix spike duplicates) provide an indication of matrix effects on analyses and do not require reanalysis if method-related QC samples (e.g., method blanks, method spikes, and method spike duplicates) indicate acceptable performance.

When the appropriate corrective action measures have been defined and the analytical system is determined to be in control, the analyst documents the problem, the corrective action, and the data, thereby clearly demonstrating that the analytical system is in control. Copies of the documentation are provided to appropriate management staff members and the QA/QC Officer for eventual addition to the project files.

1.18 QA Reports to Management

The ANG/CEVR Project/Site Manager will rely on written reports and memoranda documenting data assessment activities, quality audits, nonconformances, corrective actions, and quality notices. A copy of all significant QA reports will be forwarded to the Program Director for review and oversight.

Appendix E

APPENDIX E

SAMPLE OUTLINES FOR THE REMEDIAL INVESTIGATION AND FEASIBILITY STUDY REPORTS

REMEDIAL INVESTIGATION REPORT
(SAMPLE OUTLINE)

EXECUTIVE SUMMARY: This is a short synopsis of what was done, what was found and what conclusions and recommendations were reached. This should be done for each site. Each site discussion should be limited to one or two paragraphs. The total Executive Summary should be no more than two or three pages.

1.0 INTRODUCTION: This should include a discussion of the IRP process. The purpose of the Remedial Investigation (RI) should be discussed in more detail than other phases of the IRP including how the RI relates to the other phases and possible further actions (RA, DD, etc.). The IRP flow chart should be included in this section.

2.0 FACILITY BACKGROUND

2.1 FACILITY HISTORY: Overall base history should be discussed, including mission (past and present) and aircraft operations (past and present). Provide any other events in the history of the facility that could relate to environmental studies. Provide a map showing the location of the base within the state. Prior investigations should be discussed in this section. In most cases, the only prior investigations will be the PA and SI. List sites that were recommended for DDs. Defer discussions of sites under study (RI) until the next section.

2.2 SITE DESCRIPTIONS: Provide a map showing the IRP sites on the base. This is a site by site description of, and discussion of why, each site was selected for study in the RI. This should include findings from the Site Investigation and history of sites.

3.0 ENVIRONMENTAL SETTING: Provide topograhic information, regional and local geology, soils, groundwater and surface water hydrology. Maps and figures should include, soils map, geology maps, stratigraphic column and surface drainage map.

4.0 FIELD PROGRAM: Site specific information should be avoided in this section. This section is intended to summarize the methods used in the field program.

4.1 SUMMARY: Discuss overall approach, such as screening versus confirmation sampling activities and locations.

4.2 DEVIATIONS FROM THE WORK PLAN: This is a discussion of base wide deviations from the Work Plan, such as substituting one drilling method for another due to unexpected conditions, changing sampling protocols, or changing lab methods, etc. If extra sampling is required at a site, or there is a change in the sampling locations at a site, then supply information in the discussion for that particular site under Investigation Findings (Section 5). If there are no significant base wide deviations, then this section may be omitted.

4.3 FIELD SCREENING ACTIVITIES: Discuss only the screening methods employed in the field program. Avoid site specifics. Discuss the methods and uses of the various techniques employed, including:

4.3.1 Geophysics

4.3.2 Soil gas survey
4.3.3 Hydropunch
4.3.4 Piezometer Installation

4.4 CONFIRMATION ACTIVITIES: Avoid site specifics (Section 5 will address). Include discussion of the following:

4.4.1 Soil Borings
4.4.2 Surface Sampling
4.4.3 Monitoring Well Installation
4.4.4 Specific Media Sampling (List analytical methods used for the different media. A table may also be provided to summarize activities).

4.5 INVESTIGATION DERIVED WASTE: Discuss the methods used to handle drill cuttings, waste water, decon, etc. State how they were disposed of, or if they remain, recommend how they should be disposed of.

5.0 INVESTIGATION FINDINGS

5.1 BASEWIDE GEOLOGIC AND HYDROLOGIC INVESTIGATION RESULTS: Discuss overall geology/hydrology as determined through the field effort. Provide base wide potentiometric map along with a table displaying dates, elevations and depths to groundwater, etc. Discuss also any geologic conditions that may affect contaminant migration, such as confining layers, perched groundwater, etc. Cross sections may also be provided to aid in describing the local conditions.

5.2 BACKGROUND SAMPLING RESULTS: Discuss background sampling locations, analytical results, constituents that exceed ARARs/MCLs, etc.

5.3 SITE FINDINGS (Site 1 - Site X site by site presentation): Section 5.3=Site 1, Section 5.4=Site 2, etc. Maps and other figures displayed in this section should show all pertinent details referred to in the text, including sample locations, USTs with associated piping and pumps, oil water separators, ditches, etc. Show paved and unpaved areas, building titles and numbers. All maps and figures should include North arrow, full title, scale, date, legends and other pertinent information as appropriate.

5.3.1 Geologic and Hydrologic Investigation Results

5.3.2 Screening Results: This section is intended to discuss soil gas survey results. If a soil gas survey (or similar systematic data collection technique) is performed at the site, a map of the results should be displayed in this section. However, bore hole screening results should be included in the appropriate appendix. Screening results should be discussed in this section as they pertain to selection of samples for laboratory analyses and comparison of results.with samples analyzed.

5.3.3 Soils: Discuss soil study findings, including surface and subsurface. Provide maps of borehole locations, contoured to show distribution of contaminants (one map for each significant contaminant). Cross sections should be provided, showing distribution of contaminants and lithologies. Show the water table on the cross sections. Data tables should be organized to clearly show analytical methods, the boring number and elevation from which the samples were collected, contaminant levels, and detection limits for non-detects. Duplicates (and other appropriate QC samples) should be displayed on the table next to the samples for which they were duplicated. All other QC samples associated with the site should be displayed in table form also. Any anomalous results should be discussed. Comparisons with background should be made during these discussions.

5.3.4 Groundwater: The layout for groundwater findings should be similar to the section on soils. Provide a potentiometric map for the base showing piezometer and monitoring well locations and water level data. In addition, contour contaminant levels.

5.3.5 Conclusions: Compare results to background, ARARs/MCLs, etc. Include any immediate response actions taken. Data gaps (site specific) should also be discussed.

6.0 DISCUSSION OF ARARs

7.0 CONTAMINANT FATE AND TRANSPORT

7.1 Potential Routes of Migration

7.2 Contaminant of Persistence

7.3 Contaminant Migration

8.0 BASELINE RISK ASSESSMENT

8.1 Chemical and Physical Properties of Contaminant of Concern

8.2 Human Health Evaluation

8.3 Ecological Evaluation

9.0 CONCLUSIONS

10.0 RECOMMENDATIONS

11.0 REFERENCES

APPENDICES:

TECHNICAL MEMORANDA ON FIELD ACTIVITIES
FIELD CHANGE REQUEST FORMS
SCREENING RESULTS
PIEZOMETER/MONITORING WELL CONSTRUCTION DIAGRAMS
BORING/WELL LOGS
AQUIFER TESTING RESULTS
CHAIN OF CUSTODY
ANALYTICAL DATA AND QA/QC EVALUATION RESULTS (Include data validation reports)
INVESTIGATION DERIVED WASTE MANAGEMENT (Data tables, correspondence)

FEASIBILITY STUDY REPORT
(Sample Outline)